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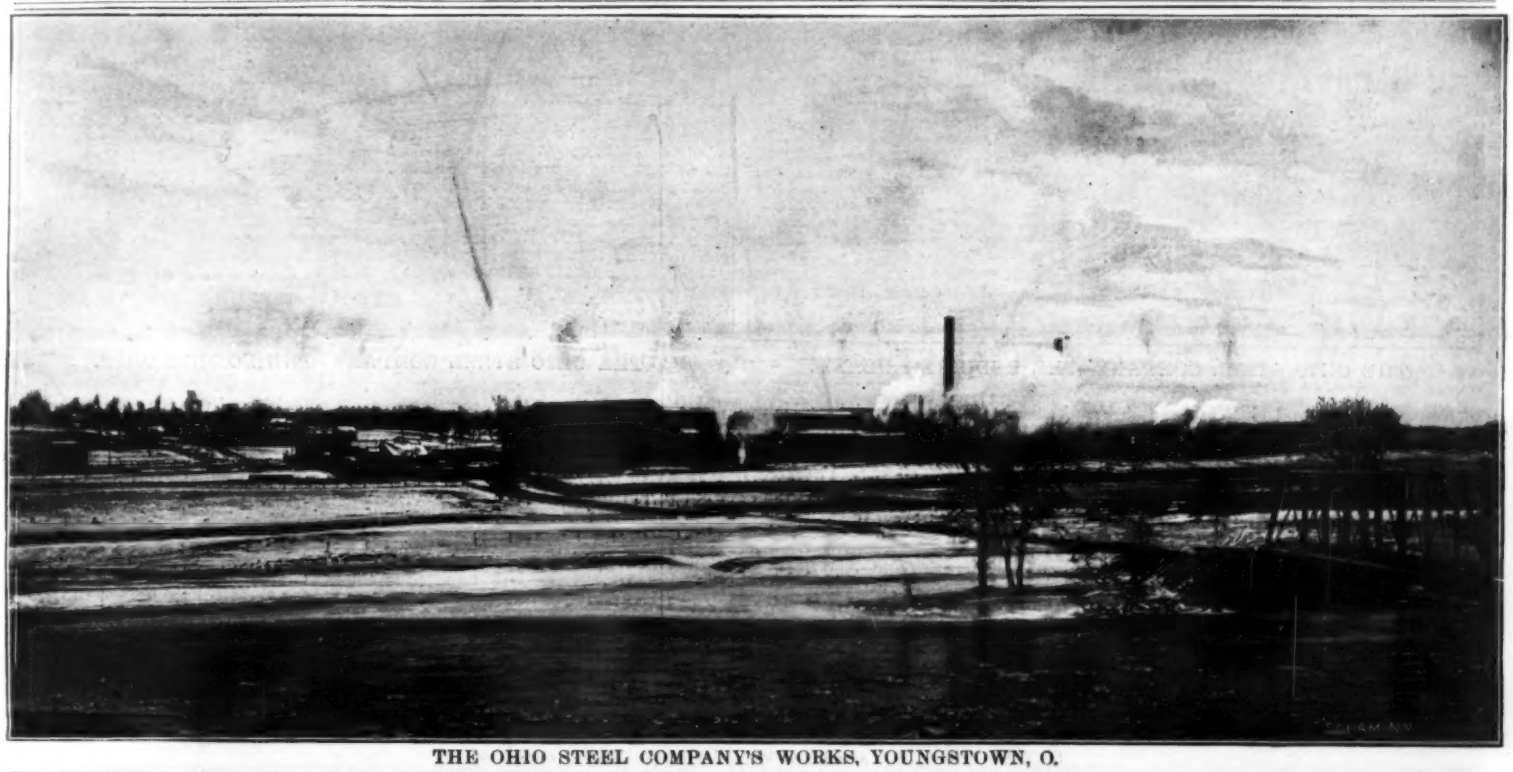


THE OHIO STEEL COMPANY'S WORKS, YOUNGSTOWN, O.

THE OHIO STEEL COMPANY—THE BLOWER ENGINE.

THE OHIO STEEL COMPANY'S PLANT AT YOUNGSTOWN, OHIO.

NOWHERE is man's smallness, his utter powerlessness, so emphasized as in the presence of his own creations—the machinery he has invented, designed and built to do his bidding and to bow to his behest. He is the Frankenstein who has conjured up the monster of iron and steam and electricity, and Frankenstein is insignificant beside his creations. This applies more especially to some iron foundry or steel plant, where everything is on a gigantic scale, where tons are as ounces, where thousands are as units. Such a place is the new plant of the Ohio Steel Company, at Youngstown, Ohio, which began operations some six weeks ago.

This plant is located at the western end of Youngstown, near Brier Hill, on the southern bank of the Mahoning River, and covers about ten acres of ground, although the surrounding yards are much larger. It is said that this plant is the most complete in this country, if not in the world. Electricity has literally been harnessed, and where formerly ten men were required, now only one is needed. Electricity is the slave and does its work well, for there are only 1,000 men employed at the works, divided into two shifts of 500 each. The plant is practically owned by Youngstown men, the two million required for its erection being subscribed by local capitalists. The Wick family, the Tod family and the Taylor family are the proprietors, Henry Wick being the president and manager of the company.

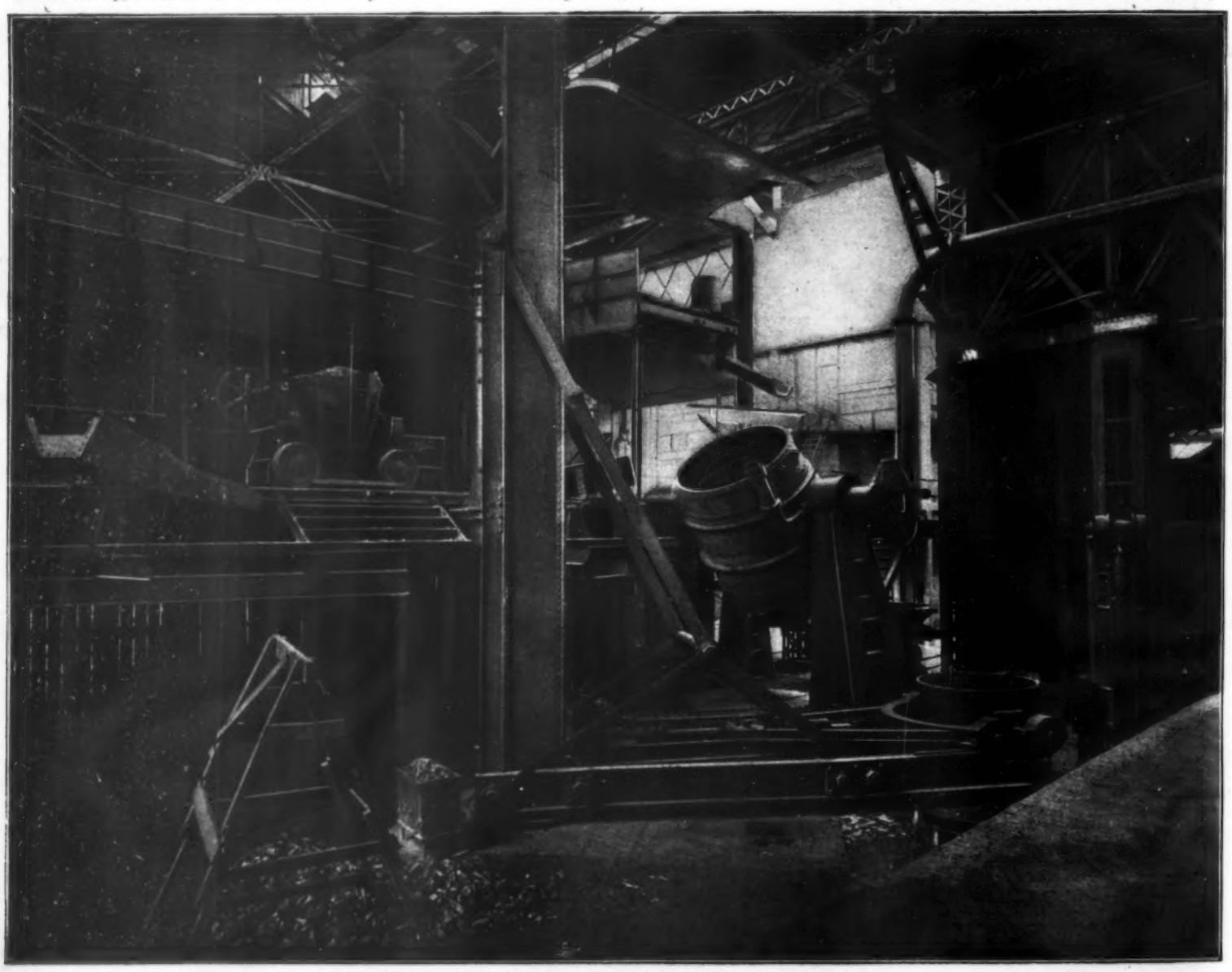
The entire plant, buidings and fences, is painted a dark red, and looks no more attractive than most of such structures. But what it lacks in external beauties it makes up in interior interest, for there are only few places more interesting than a steel plant. A trip through the one in question is especially interesting, because it proves conclusively that American enterprise and American ingenuity are superior to all competitors, irrespective of nationality. There are several divisions, as shown in the accompanying illustrations, made especially for this paper, a few days before the machinery was started.

The establishment is in reality divided into two departments, the converting and the blowing and billet mills. The converter department is located in a separate building in the southern portion of the yard. There are two Bessemer converters, 9½ feet in diameter and 12 feet deep. They are mounted on trunnions, so constructed that they can be shifted in any direction at will, by means of hydraulic pressure. The converters are filled with molten pig iron, reduced to fluid state in the cupola department. In this department there are four cupolas, each 10 feet 6 inches in diameter and 24 feet high. From them the molten mass is conveyed in a huge ladle, on a car driven by electricity. The charge, as the metal is called, is weighed and then poured into the converters. These converters are of the regulation Bessemer type and need no detailed description. They are massive and ponderous, but being nicely balanced, are as easily handled as though they weighed only a few pounds.

In each heat ten tons of steel are blown, the process taking from eight to ten minutes, making a total of three hundred heats for the two converters in twenty-

THE OHIO STEEL COMPANY—THE REDUCING PLANT

THE OHIO STEEL COMPANY—THE FORCE PUMPS.



THE OHIO STEEL COMPANY—THE BESSEMER CONVERTERS.

four hours. The blast for the converters is furnished by a blowing engine, as shown in the accompanying picture, which is known as the cross compound and condensing horizontal blowing engine. The pressure at the tuyeres at the bottom of the converters is 25 lb. to the square inch.

The process of blowing is the most interesting of all. The hiss and roar of the escaping gas is full of evil forebodings, happily unfulfilled, as though some bad spirit were escaping from imprisonment. At the beginning of the blast the flame is short and not highly luminous. The spectroscope shows a continuous spectrum without lines. Soon the flame increases in size and brilliancy; it becomes deep yellow or orange, with bluish streaks, intermingled with sparks from the metal. This is known as the slag or cinder forming period. Next comes the violent period, when the noise is deafening. The molten mass gurgles and bubbles and seems on the point of boiling over. The flame becomes dazzling in its intensity, and the spectroscope shows bands of dark lines in the green. Then comes the last and peaceful period, when the flame becomes intensely hot and purple or violet in color. The noise becomes less and less, the flame grows dimmer, and then, a puff of brown, dusty smoke announces that the blast is finished.

After the steel is blown and carbonized, it is poured into another giant ladle swinging on a twenty ton hydraulic crane, which swings it to where the ingot moulds stand vertically, ready for the metal. The ingots when filled are rolled to the ingot extractor some hundred feet away, by means of a narrow gage railroad with diminutive locomotives. Once at the ingot extractor, the moulds are removed and the ingots are conveyed to the heating furnaces and are placed into the fires by means of a very ingenious electric traveling crane which takes the metal and deposits it in the furnaces, working automatically. When the ingots are properly heated, they are taken to the blooming mill on an electric car.

Here the ingot, which by this time has been reduced to 18 inches by 22 inches at the base, is reduced by thirteen passes to a bloom 6½ by 7 inches square. It is then conveyed into and through three billet mills, each operated by an independent engine and placed parallel to each other. The cylinder of the largest of these three engines is 46 by 60 inches, the other two being 40 by 60. The largest of the three flywheels, which is shown in the accompanying illustration, is one of the largest in America, and is thirty feet in diameter, weighing eighty tons. The other two, which pale in comparison by the side of the monster, weigh only 144,000 lb. each.

Between the mills are tables for conveying the steel as it is being rolled, which are operated by thirteen 25 horse power electric motors. The engine house, which adjoins the mill just described, contains the immense pumps for furnishing the blasts for the cupolas and the engines for generating electrical power and light. This building is 57 by 227 feet.

The three hydraulic pumps in the engine house are tandem compound duplex pumps, built to produce a pressure of 750 lb. to the square inch throughout the entire hydraulic system of the plant. The steam plant consists of 3,400 horse power, the working pressure of the boilers being about 150 lb. In boiler house number one are eight boilers of 250 horse power each, and all are equipped with Murphy smokeless furnaces, which consume their own smoke, and with Jeffrey coal conveying apparatus by which sixty tons of coal can be supplied to the furnaces in one hour. An additional plant of 1,500 horse power is in the course of erection and will be completed very soon.

In adjoining buildings are the machine shop, fitted with the latest appliances: the blacksmith shop, the warehouse and the laboratory.

Around the mills are about five miles of narrow gage tracks, so arranged that manual labor, as far as carrying is concerned, is almost unnecessary. Broad gage tracks connect the works with the "Nypano" and the Pennsylvania systems.

In all, there are twenty-eight electric motors, one incandescent dynamo, one arc light dynamo, two power dynamos and a number of minor electrical generators.

The plant will be of great benefit to the city of Youngstown, for the monthly pay roll amounts to about $40,000. In addition to this, a new settlement called Steelton has sprung up near the works, and it is an assured fact that within the next twelve months there will be from three to four hundred houses erected at this spot.

The product of this plant will be billets of all sizes, sheet and tin plate bars, T rails and structural steel. The output will be from 1,000 to 1,500 tons per day, 150 tons of coke, 50 tons of limestone and 200 tons of coal being consumed every twenty-four hours. The gas used in the ovens, etc., is manufactured on the premises, as shown in one of the pictures.

The steam engines were built by William Tod & Company, of Youngstown. The entire plant was designed by Julian Kennedy, who is favorably known through his connections with the Carnegie and the Latrobe (Pa.) steel companies.

Taken all in all, the Ohio Steel Company's works can justly be considered as a subject of legitimate pride by Youngstown, by Ohio and by the entire country.

THE OHIO STEEL COMPANY—THE GAS GENERATORS.

[Continued from SUPPLEMENT, No. 1017, page 16252.]

RUSTLESS COATINGS FOR IRON AND STEEL.*

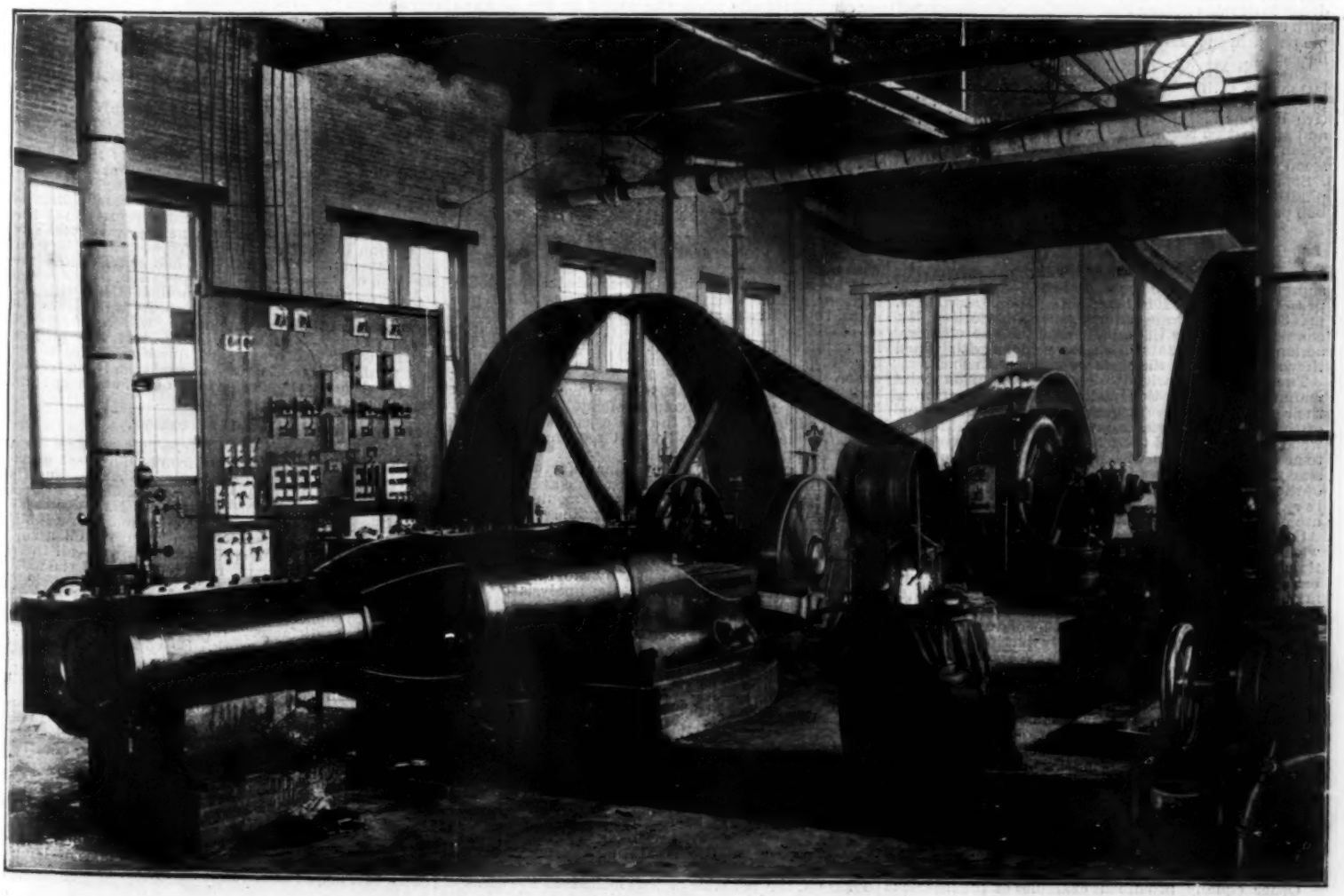
PAINTS: OF WHAT COMPOSED, HOW DESTROYED, CLASSIFICATION AS TRUE PIGMENTS AND INERT SUBSTANCES, ADULTERANTS, ETC.

By M. P. WOOD, New York City, Member of the Society.

NATURAL AND ARTIFICIAL ASPHALT COATINGS.

MANY of the characteristics of both of these materials for protective coatings for iron and steel structures have been given in a previous paper, No. 598, presented at the Montreal meeting (June, 1894), and forming part of vol. xv of Transactions, pp. 1016, 1020, 1021, 1039, 1040; also their adaptability for the protection of marine work, both anti-corrosive and anti-fouling,

* Presented at the Detroit meeting (June, 1895) of the American Society of Mechanical Engineers, and forming part of Volume XVI of the Transactions.



THE OHIO STEEL COMPANY—THE DYNAMO ROOM.

given in a second paper, No. 626, presented at the New York meeting (December, 1894), and forming part of vol. xvi of the Transactions, p. 385.

With proper care in their preparation to eliminate the ammonia and organic matter subject to decomposition and the formation of corrosive acids, and when applied hot to clean dry surfaces free from mill scale and warmed to any degree under that of boiling water, they are not only cheap in cost, but seldom need renewal, and form one of the best of protective coatings to resist not only corrosion, but decay in all bodies, ferric or other, and prevent, in a great measure, the passage of moisture and the familiar sweating of objects at sudden changes of temperature. Enameled articles and the japan varnishes have as their base asphalt tempered with some admixture of linseed oil and varnish gums. Some are dried by baking in ovens, forming enameled ware; others applied with a brush dry by evaporation of their solvents rather than by oxidation.

Engineering News, February 7, 1895, p. 86, contains a lengthy and instructive abstract of a paper read at a meeting of the New England Railroad Club, January 9, 1895, "Preservative Coatings for Iron Work," prepared by A. H. Sabin, chemist for Edward Smith & Company, varnish makers, New York City, co-jointly with Mr. A. O. Powell, United States assistant engineer, St. Paul, Minn. The article is too long to incorporate with this, but is worthy of reading and a place on the file of any engineer interested in this subject. Briefly, an ideal coating was prepared after long experiment from asphaltum, "maltha" (a petroleum by-product), linseed oil and certain varnish gums that partook of the nature of an enamel when exposed to an oven heat of 400° to 600° F. for several hours.

Some 14 miles of 38 inch diameter steel riveted pipe $\frac{1}{4}$ inch thick, in sections 28 feet long, were dipped in this coating and baked into an enamel in a vertical oven; then taken to the trench and riveted up into a continuous line, the local damage in handling the pipe sections, riveting them up and by the rivets being met by some sort of an undescribed compound entirely foreign to the baked coating applied in one coat by a brush at the rate of from 3,000 to 6,000 square feet of surface per ten hour day by two men (one inside the pipe and one on the outside surface). And as Mr. Sabin acknowledges that some 20 per cent. of the enamel coating was injured to a greater or less extent in the operations between the bake ovens and covering in of the pipe (the latter part signifying its acceptance by the engineer in charge of the work on the part of the city of Rochester), the writer wonders why such a job of mechanical fiddlesticks should be set forth at such length as in the above paper describing a process of how not to do it.

Engineering News, April 4, 1895, p. 226, "Preservative Coatings for Steel Pipe on the Rochester Water Works," contains an instructive criticism by Willard D. Lockwood, Jr., A.S.C.E., on Mr. Sabin's ideal coating for the Rochester pipe as actually applied that should be read by all engineers. If the results to be had at Cambridge, Mass., on the 23,000 lineal feet of 40 inch pipe are no better than those obtained at Rochester, one can but wonder what phase of engineering rabies has attacked the craft to lead the engineer in charge at Allegheny, Pa., to select this preservative process for 10 miles of 60 inch diameter water pipe that city is to lay, which process thus far has proved of a more perishable and dangerous character from the tendency to develop pitting than had the pipe been coated with some one of the many old, well known and reliable paints in the market, or washed over with hydraulic cement.

The ideal varnish recommended by Mr. Sabin in the latter part of his February 7 article cannot take its place too soon in a practical form among the preservative compounds of the day, even if its preparation and application require the presence of skilled supervision in the future, as recommended by Mr. Sabin, instead of the haphazard methods of the past.

Some additional data relative to the nature of asphaltum will be given under the fourth class, as carbon paints.

IRON OXIDE PAINTS.

The characteristics of these paint compounds have been so fully set forth in the preceding papers that it is superfluous to refer to them in much detail here. Paper 598, vol. xv, pp. 1014-1020; also paper 626, vol. xvi, pp. 386-408, 409, Transactions American Society Mechanical Engineers (1894, 1895), describe the chemical action of these paints upon the vehicles with which they are mixed and the surfaces coated with them.

The persistency with which the iron oxide paint manufacturers push their claims for the recognition of their product as the only great preservative compound of the day for all surfaces, metallic as well as those of wood or mineral, and the readiness of some engineers to accept their claims without investigation, notwithstanding the many instances that these paints present of their failure as anti-corrosive compounds, necessarily requires me to illustrate some facts relative to their use not otherwise noticeable.

Scores of important iron structures have been coated with these paints under the best conditions of application, the non-protective character of these compounds being painfully apparent to any person who has examined the Victoria Tubular Bridge over the St. Lawrence River at Montreal; the trusses and lattice iron work of the Brooklyn Bridge; the elevated railway structure of New York City, notably that important portion, completed within the last few years, that carries the Washington Heights and Macomb's Dam roadway over the One Hundred and Fifty-ninth Street elevated railway station, where the combined effects of mill scale, iron oxide paint, sea air, steam and the products of combustion from the many locomotives daily passing under the viaduct afford as prominent an example of engineering blundering as the present decade has thus far developed.

So rapidly has corrosion in the latter case developed that it is safe to assume that this important structure will succumb to its effects within 25 years from the date of its erection, unless some more drastic remedy is applied to check it than the dabbing of a paint brush dipped in a 60-cents-per-gallon paint.

Other equally prominent examples of the injurious effect on ferric structures of the use of these iron oxide paints could be cited if needed to warn engineers against their further use as protective coatings. The trade marks covering these paints are numerous, and whether as kings, princes, potentates or other euphonious metallic browns, asbestos and silica combinations, their ravages on metallic surfaces are clearly discernible at all times, except immediately after the application of a fresh coat to cover the injuries of the past ones.

The color of these oxide paints is, in general, a pleasing one, and has had much to do with their extensive use. These colors, ranging from a bright red without a brownish cast to that of a disagreeable purplish hue, are the result of the different processes of manufacture of the dry pigment, different iron ores used as the metallic base; also of the fineness of grinding and the admixture of different amounts of japan drier and turpentine during the grinding. The worst offenders, in a corrosive sense, are those of the brightest color, which, being made from the calcination of copperas, contain so large an amount of sulphuric acid, not driven off by the heat of calcination, as to require the addition of inert substances to correct, notably carbonate of lime, which is changed by combining with the sulphuric acid present in the oxide to a sulphate of lime, of itself not an injurious substance in a pigment. These inert substances (not true pigments) govern the color of the oxide paint to some extent, but the color is no criterion of the purity or merit of the iron oxide pigment.

Much stress is laid by the manufacturers of iron oxide paints on the large quantities sold to the national governments of the world, for use on the many iron structures committed to their care and preservation, with a too frequent implication that no other protective covering is effective; whereas, there is scarcely a government bureau of construction and repair in the whole world that does not specially prohibit the use of these paints on any important metallic structure under their control.

To such an extent has this game of iron oxide brag extended that the Verein zur Beförderung des Gewerbfleiss (or Society for the Promotion of Useful Arts), Berlin, Prussia, has offered a silver medal and prize of one hundred and fifty pounds for the best paper giving a chemical and physical analysis of the oxide of iron paints in general use for anti-corrosive purposes. This paper will be made public at some date during the present year, and it is hoped will serve as a text book to instruct the rising corps of engineers upon the question of what not to use to prevent corrosion in metallic bodies.

The specifications for iron oxide paints mixed ready for spreading, in use by many of the leading lines of railway in the United States for their freight car and wooden structural work; also used, with some modification in color, for the covering of iron trusses, bridges, roofs and other metallic work; also adopted by many bridge builders and iron structural manufacturers, architects, and others to coat their work before erection and when in place, are generally about as follows:

Pigment, 75 per cent.; liquid, 25 per cent.; both by weight. The pigment to be composed of sesquioxide of iron, 50 per cent.; carbonate of lime, 5 per cent.; fully hydrated gypsum, 45 per cent. If the sesquioxide of iron is less than 40 per cent., or the liquid less than 23 or more than 27 per cent., the sample is rejected; also if it contains less than 2 or more than 5 per cent. of carbonate of lime uncombined; also if more than 2 per cent. of volatile matter be found in the oil when dried at 350° F. If barytes or other inert substances, color, or material less opaque than sulphate of lime is found, the sample is rejected. Even with so large a quantity of inert material as given above, or fifty per cent. of the pigment, these oxide paints have good covering power, and are still so strong in oxidizing qualities as to materially hasten the decomposition of the oil and shorten the life of the paint. The practice of master painters and color chemists is from year to year to lower the amount of sesquioxide of iron in the pigment, and if another 5 per cent. was taken out of the above proportions, the paint, so far as its application to iron structures is concerned, would be materially improved.

A proportion by volume of 35 to 30 per cent. of pigment and 65 to 70 per cent. of liquid gives a good result with nearly all paints.

If to each gallon of oil there be added as much dry pigment as four times the specific gravity of the pigment, the different amount of pigments that a gallon of oil will require to form a good spreading and covering paint will be as follows: Dry white lead, 26·4 lb.; dry white zinc, 21·2 lb.; Indian red, 20 lb.; yellow ocher, 12 lb.; umber, 11·84 lb.; bone black, 10·4 lb.; freight car color, 9·20 lb.; the percentages of the above being 67·40 per cent. by volume of liquid and 32·60 per cent. of pigment. Or, if the white lead was mixed as a paste, one gallon of oil would require 41·80 lb. of white lead paste to spread well.

The reluctance of the principal manufacturers of iron oxide paints to furnish the public with correct analyses of their product, either as dry pigments, paste, or color, is nearly equaled by their readiness in quoting the low price at which it can be obtained in comparison with red lead and other pigments.

A noteworthy example to the contrary is found, however, in the data furnished by the Prince Manufacturing Company, who give the analysis of their Prince Brothers' mineral brown paint, viz.:

Peroxide of iron, Fe_2O_3	52·11
Carbonate of lime	0·23
Silica	46·03
Moisture	1·59
Loss	0·04
	100·00

They also furnish the following data, not known generally to engineers, which is of interest enough to place upon record.

Prince Brothers' mineral brown may be used as an effective substitute for the Bower-Barff process upon iron and steel that can be heated to a bright red, by simply mixing the pigment with resin oil (which costs about 15 cents per gallon), and painting the mixture upon the iron, then heating it to a bright red. The oil burns off, the peroxide of iron melts into the black or magnetic oxide or rustless coating, the silica in the pigment acting as a flux, and becomes a part of the iron itself. No gas, steam, or muffles being necessary in the process; only to heat the article coated with the above composition; the cost is only nominal for the pigment and oil. This effect is easily shown by thus coating a piece of iron and heating it in a common stove or grate fire. The process is not patented, but is quite as effective and more meritorious than many of the preservative processes that are thus honored.

A paper presented by Mr. Emil Gerber, Member A. S. C. E., at their May meeting, New York City, 1895, "Preservation of Iron Structures Exposed to Weather," gives the result of a personal examination of a number of iron bridges and structures coated with iron oxide and other paints, and compares their condition with each other. It is the strongest and best presentation of the merits of iron oxide paints ever published, and will give great satisfaction to those who believe in that sort of a pigment.

Mr. Gerber's examinations were confined to iron structures erected at inland points, and in a subsequent communication he infers that, for structures exposed to sea air, the use of red lead, or some other paint compound, might give a better protective result than the iron oxide paint. This appears to be a singular deduction, as it seems to the writer that any paint that will resist the corroding effects of sea air would also be the better one to use on inland structures, even if the cost of the paint was the governing factor in the case.

A query arises here, at what parallel of latitude or degree of longitude the line of useful paint effect should be drawn in determining what paint to use to protect the structure?

The iron oxide paints used on the structures examined by Mr. Gerber appear to have been made from a red hematite ore, prepared without roasting by simply being ground fine, and mixed with boiled linseed oil at the point where it was used. Its color was a brown purple. The chemical composition of the pigment, from an analysis submitted by the manufacturers, and one from an independent source, is of interest, as showing the sublime faith of the advocates of iron oxide in the protective qualities of comparatively a pure iron, minted into a paint and spread over another ferric body to preserve it from corrosion.

Substances in the Pigment.	Manufacturers' Analysis.	R. W. Hunt & Co.'s Analysis.
Sesquioxide of iron, Fe_2O_3, the chemical equivalents being 70 per cent. iron and 30 per cent. oxygen	93·68	92·40
Silica	3·20	3·36
Alumina	3·06	1·69
Lime	0·00	0·84
Organic and volatile	0·00	0·85
Magnesia	0·00	0·48
Sulphur	trace	0·029
Loss	0·06	0·351
	100·00	100·00

A comparison of this pigment with the specifications mentioned above may account for the anxiety manifested by the bridge engineers at the appearance of corrosion on the structures erected by them, the preservation of which, by the use of a paint of their own selection, was supposed to be of importance enough to warrant an effort to secure the best result from a protective coating at least commensurate with the engineering ability expended upon the design and erection of the structure.

Mr. Gerber cites that a number of analyses of iron oxide paints, ordered from the same manufacturers at different times, varied so greatly in the composition of the pigment and the wearing qualities of the paint as to finally warrant their rejection; that the exact composition of the paints when applied was unknown, and when the early decay of the paint was manifest no records were available to prevent a repetition of the failure. And the writer adds, neither was there any confession on the part of the engineer as to how far the element of "Cheap John" had entered into the selection of the paint and its application.

A comparison of Mr. Gerber's deductions with the results obtained by the use of graphite pigments as per samples presented for examination, will be of interest to the members of the A. S. M. E., and may prove a partial solution of the vexed question, What is the best pigment to use to prevent corrosion? and will do much to remove the matter from one of argument and experiment to that of practical use.

ZINC AND LEAD OXIDES.

Oxide of Zinc or Zinc White.—This pigment as a preventive of the corrosion of iron is in a great measure removed from consideration, notwithstanding its cheapness and desirable color. Its tendency to peel or flake off from metallic surfaces, its early decomposition when exposed to external atmospheric influences, and its tendency to form with the oil a zinc soap compound that is easily washed away—all these difficulties combined have rendered its use of the most unsatisfactory character.

Mixed in equal parts with white lead and ground with pure boiled or raw linseed oil, its use is in a measure satisfactory for house painting, either for inside or external work. So combined its use is very general in all of the tinted or colored paints that crowd the market under many trade mark names, with varying qualities of usefulness and durability.

When mixed with the red oxide of lead in the proportions of one-quarter to one-third zinc to three-quarters or two-thirds red lead, and ground together in raw linseed oil, it forms a very durable and effective coating for iron surfaces, either as a protection from corrosion or as an anti-fouling compound for surfaces wetted in sea water. (See Transactions A. S. M. E., vol. xvi, pp. 400-403, Report of Paint Tests, U. S. Navy, 1885.) When so mixed the "setting" action of the red lead is delayed, about the same as when lampblack is mixed with red lead. An ounce of lampblack to a pound of red lead delays the setting of the red lead paste some thirty days. Japan driers can be added at the time the oil is added to thin the paint

for application, in order to make the paint quick-drying.

WHITE LEAD (HYDRATED CARBONATE OF LEAD), SUBLIMED LEAD, LEAD OXIDES, RED LEAD, (MINIUM), PYROLUSITE, MnO_2 (OR MANGANESE DIOXIDE ORE).

White Lead—Hydrated Carbonate of Lead.—The native anhydrous carbonate is also called white lead ore or cerusite, $PbCO_3$, specific gravity 6·465 to 6·480, and is found in various parts of the world.

There are two methods of preparing white lead pigment. In the older or Dutch method, thin sheets of lead are placed over gallipots containing a weak acetic acid (water with 2½ per cent. of strong acid), the pots being embedded in fermenting tan bark, the temperature of which varies from 140 to 150 degrees F. A quantity of vinegar, containing not more than 50 pounds of strong acetic acid, converts 2 to 2½ tons of sheet lead into the carbonate in a few weeks. The lead is neither oxidized nor carbonated at the expense of the acetic acid. The oxygen is derived from the air, and the carbonic acid from the fermenting tan bark. The acid serves to dissolve the oxide of lead and convert it into a basic acetate, which is easily decomposed by carbonic acid, the acetic acid being thereby set free to act upon another portion of the oxide of lead.

This is shown to be its mode of action by what takes place in the more modern process, in which oxide of lead (litharge, the scum of silver ore, called also massicot) is mixed with water and about one per cent. of neutral acetate of lead—sugar of lead ($C_2H_3O_2$) 2Pb or Pb'O, $C_2H_4O_2$—and carbonic acid gas is passed over it. In this manner the oxide is quickly converted into excellent white lead.

The nitrate of lead has also been employed in this process instead of the acetate. White lead is often mixed with barytes, gypsum and oxide of zinc to render it less liable to be blackened by the action of sulphureted hydrogen; the addition of whiting, sulphate of lime, and other of the inert pigments being readily detected by the change in its specific gravity when dry, and by various methods of analysis when ground in oil either as a paste or a paint. A comparison of its combining power with oil as compared with other pigments is given above.

White lead, when pure and carefully ground with pure oil, without drier, and allowed to take its time to dry thoroughly before another or the second coat is applied, forms a very effective coating to prevent decay in wooden structures or corrosion in iron. The pigment being held to the surface coated by its combination with the liquid, the oxidation of the oil from atmospheric exposure leaves the pigment free to come away as a fine powder; and in cases where the paint has been exposed for a long period without being dressed with a coat of oil, the pigment will be found to be quite easily removed by passing the hand over it.

When protected from the direct action of the elements and the sun, as on the under side of cornices, etc., the paint will be found hard and resistent after the lapse of many years. Its color readily shows the progress of any decay or corrosion beneath it, and this virtue alone causes its rejection as a protective coating, even if the cost of it were of no consideration.

Many instances of its effectiveness as applied to iron to prevent corrosion can be cited. One of them, from the prominence of the circumstances, is here given (restated from vol. xv, p. 1015):

The iron material in the old Hammersmith Bridge across the Thames at London, England, was bought to use as false work at the new Forth Bridge, Scotland. The iron, after sixty-two years of service, was as good as new. Many of the parts were inaccessible, and had not been repainted since their erection. Pure white lead paint was what had preserved them.

Lighthouses, beacons and signal stations at numerous points on the coast in all parts of the world show, even in their exposed positions, the protective power of good white lead paint. A condition precedent to its application should be the removal of all scale and grease, an absolutely dry and clean surface, and a clear, bright atmospheric condition during the drying.

Sulphite of Lead.—$PbSO_3$, prepared by the double decomposition, or by passing sulphurous oxide into a solution of neutral plumbic acetate, has been proposed as a substitute for white lead. It is a white, insoluble, anhydrous powder, which, when heated, gives off sulphurous oxide and leaves a mixture of sulphate and sulphide. There is no record of its qualities as a protective agent on any structure that would lead to its general use in preference to white lead.

Sublimed Lead, $PbSO_4$ (White Paint).—A new preparation of lead, a by-product obtained in the smelting of non-argentiferous lead ore, is coming into prominence as a substitute for corroded white lead prepared by the Dutch process as a pigment. It is also known in the trade as Joplin lead, from its place of manufacture, Joplin, Mo.; also as Picher lead, from the name of the manufacturing company. It is made in two colors: white, used for all colors incident to the use of ordinary white carbonate of lead; and blue, which is a preferable color when used as a pigment for iron, or as a material in the manufacture of rubber, etc. Whatever good qualities the white has are also shared by the blue. The chemical composition of sublimed white lead is a sulphate and an anhydrous oxide of lead, both amorphous. Incidentally, there is a small percentage of zinc oxide in the pigment, the Missouri lead ores containing a small amount of zinc; but it is generally conceded that the zinc oxide is no detriment to the lead pigment.

The sublimed lead is prepared in special furnaces, in which the mineral is roasted, and is one of the products of sublimation and partial oxidation of galena ore with bituminous coal as a fuel, and owes its dark color to the lead sulphide and carbonaceous matter in it. The galena ore is first smelted with raw coal and slaked lime in a furnace, using an air blast to obtain the required heat; the hotter the fire, the more lead is volatilized, and the more "fume" is produced. The products of this smelting are pig lead, pasty slags containing more or less lead, zinc, and other constituents of the galena ore and the "fume." The latter is drawn off by an exhaust fan through a settling chamber to a bag house, which contains a large number of woolen bags for filtering the fume out of the gases. This "fume" is a lead colored, impalpable powder known as "blue powder." It is ignited and allowed to burn for several hours, which converts it into white, coherent crusts. These crusts, with some oxidized ores and hearth slags, are next charged into a special furnace with a very hot coke fire. The products of this smelting are pig lead, slags poor enough in lead to be thrown away, and the "fume," which in this case is perfectly white and in a fine state of subdivision, suitable for a white pigment, and is sold as such either dry or ground in oil, as is usual with carbonate or white lead products.

The process is the same in principle as used in collecting the oxide of zinc for use as a paint. The use of "fume" from the smelting of lead for a paint is very old; Bishop Watkins, in his scientific writings in 1778, mentions the use of the gray fume, but its color was then objectionable.

An analysis of some samples of the white powder gave:

Insoluble	0·08	0·08
$PbSO_4$	65·46	65·00
PbO	25·85	25·89
ZnO	5·95	6·02
Fe_2O_3	0·08	0·08
CaO	0·02	0·02
CO_2	1·53	2·00
SO_2	0·04	None
H_2O	0·69	0·85
	99·65	99·89

Some 800 to 1,000 tons are yearly manufactured by the Lone Elm Works, Joplin, Mo., the sale of the sublimed lead as a by-product enabling that smelter to be kept in operation while the surrounding smelting works were closed on account of the low price of pig lead.

The process is patented, and known as the "Lewis & Bartlett Bag Process of collecting lead fumes," and has been mentioned and more or less described as follows:

Mineral Resources of the United States, 1883–4, p. 427; Engineering, 1884, p. 495; Engineering and Mining Journal, vol. xl (1885), p. 4; B. und H. Zeitung, vol. xlvii, p. 346 (describes the works of the Bristol Sublimed Lead Company, Bristol, England, where the process is in operation); Prerass Zeitsch., vol. xviii, p. 195; Fresenius Zeitsch., vol. viii, p. 148; Transactions of the American Institute of Mining Engineers (Washington meeting, February, 1890), illustrated.

The product is sold under strong guarantees as to quality and merit by the Picher Lead Company, Joplin, Mo. It is claimed that it is but little if any affected by ammonia or sulphur fumes, products of combustion, etc., and that it does not crack or peel when applied to metallic or mineral surfaces. Its covering power is good, and, judging from the samples presented, it appears to be able to withstand the gnawing tooth of time as well, if not better, than any proposed substitute for white or red lead that has yet been presented for the consideration of engineers.

The samples in the bottles are the dry powders of the white and of the blue pigments. The sample of iron piping is painted on one end with two coats of red lead and on the other end with one coat of the blue lead pigment, to contrast the covering powers.

The samples of wood coatings are from a new picket fence, painted in 1892. Two alternate pickets in the fence were painted with the best corroded white lead and with the sublimed lead, upon the same day, by the same painter, using the same oil in both kinds of paint, applied with separate brushes, from separate paint pots, and care taken to have all the conditions as uniform and unbiased as possible. The appearance of all the samples is decidedly in favor of the sublimed lead.

I am under obligations to C. V. Petraeus, chemist and metallurgist at Joplin, Mo., for the samples presented and a description of the process and works of the company.

(To be continued.)

ABSTRACT OF "STATISTICS OF THE RAILWAYS OF THE UNITED STATES" FOR THE YEAR ENDING JUNE 30, 1894.

THE Seventh Statistical Report of the Interstate Commerce Commission, prepared by its statistician, being the complete report for the above named period, for which a preliminary income account was issued in December, 1894, has just been submitted, of which the following is an abstract.

In the introduction of the report especial attention is called to the peculiar conditions affecting the operation of railways during the year covered by the report. First, the report covers the last four months of the Columbian Exposition, during which time there was an increased passenger traffic. Second, it covers a period of widespread and unprecedented business depression. Third, on June 30, 1894, 192 roads, operating upward of 42,000 miles of line, and representing about one-fourth of the total railway capitalization, were in the hands of receivers. The effect of these conditions is apparent in nearly all of the figures presented.

MILEAGE.

The total railway mileage in the United States on June 30, 1894, was 178,708·55, an increase during the year of 2,247·48 miles. The increase during the previous year was 4,897·55 miles. The percentage of increase in 1894 was less than for any preceding year for which reports have been made to the Commission, and it is not probable that the year ending June 30, 1895, will show much improvement. The State of Pennsylvania shows an increase of 300·20 miles; Florida, 234·82 miles; North Dakota, 195·54 miles; Ohio, 184·02 miles; Georgia, 162·71 miles; Maine, 125·60 miles; Missouri, 120·51 miles; West Virginia, 117·56 miles; and Minnesota, 116·49 miles. The States of Kansas, Maryland, Massachusetts, Nevada, New Hampshire, North Carolina, Vermont, Virginia, and the Territory of Arizona show slight decreases in mileage, due to remeasurements and abandonment of lines, aggregating 153·72 miles. The number of roads abandoned was 16. The total mileage of all tracks was 233,533·67 miles, which includes 10,499·80 miles of second track; 958·16 miles of third track; 710·99 miles of fourth track, and 42,661·07 miles of yard track and sidings.

CLASSIFICATION OF RAILWAYS.

The total number of railway corporations on June 30, 1894, was 1,924, an increase during the year of 22. Of this number 745 were independent operating companies and 945 maintained separate operating accounts. The number of companies maintaining financial accounts only was 804, of which 334 were operated under lease for a fixed money rental and 190 for a contingent money rental; 243 were controlled through the ownership of stock by the operating company; the remaining 37 returned no information as to the form of control. The number of roads not in operation was 77, of which 60 were independent roads; 10 were subsidiary roads, parts of systems, and 7 were private roads. In addition to the roads already referred to there were 98 private roads operated in connection with logging, milling, and mining industries. The movement of consolidation during the year on the basis of mileage involved has been greater than for the year previous; 15 roads, representing 1,734·64 miles, have been merged; 22 roads, representing 2,351·99 miles, have been reorganized; and 14 roads, representing 1,590·34 miles, have been consolidated. A classification of railways on the basis of operated mileage shows that 44 roads, each with a mileage of over 1,000 miles, operate 100,547·29 miles of line, or 56·30 per cent. of the total mileage of the country; 23 roads, each with a mileage of over 600 and less than 1,000 miles, operate 17,918·35 miles of line, or 10·03 per cent. of the total mileage; 25 roads, each with a mileage of 400 and less than 600 miles, operate 11,724·00 miles of line, or 6·57 per cent. of the total mileage; 42 roads, with a mileage of over 250 and less than 400 miles, operate 13,508·82 miles of line, or 7·56 per cent. of the total mileage; and 907 roads, each with a mileage of less than 250 miles, operate the remainder of the mileage, 34,910·26 miles, or 19·54 per cent. of the total mileage. From this it will be seen that 90 roads, representing the first three classes, operate 72·90 per cent. of the entire mileage of the country.

EQUIPMENT.

On June 30, 1894, the total number of locomotives was 35,492, an increase during the year of 704. Of these, 9,893 were passenger locomotives; 20,000 were freight locomotives; 5,086 were switching locomotives; and 513 were unclassified. The total number of cars reported was 1,278,078. Of these, 33,018 were in passenger service; 1,205,169 were in freight service; and 39,891 were caboose, derrick, gravel, officers' pay, and other cars in the company's service. These figures do not include cars owned by shippers or private individuals. The increase in the number of cars during the year was 4,132, as against an increase of 58,854 during the previous year. This falling off in the ratio of increase is due to the fact that the railways have during the year destroyed a large number of old, wornout cars. The number of passengers carried per passenger locomotive was 62,630, and the passenger miles per passenger locomotive were 1,444,400. The number of tons carried per freight locomotive was 31,909, and the ton miles per freight locomotive were 4,016,755. With the exception of the item of passengers carried, these figures show a decrease in the efficiency of locomotives. The number of passenger cars per 1,000,000 passengers was 53, and the number of freight cars per 1,000,000 tons of freight was 1,888. During the year 1,579 locomotives and 30,386 cars were fitted with train brakes, and 1,197 locomotives and 34,186 cars were fitted with automatic couplers. While the gain in the use of both these safety appliances is largely in excess of the increase of equipment during that year, it cannot be considered as showing a marked tendency toward compliance with the law, as 74·80 per cent. of the total equipment is still without train brakes and 72·77 per cent. without automatic couplers. The law requires that all equipment shall be supplied with these safety appliances before January, 1898, while it requires that all cars shall be provided with grab irons or hand holds and drawbars of a standard height by July 1, 1895.

EMPLOYES.

The total number of railway employes on June 30, 1894, was 779,608, a decrease, as compared with the number on June 30, 1893, of 93,994, or 10·76 per cent. This is a smaller number employed than in any year since 1890. This decrease is, of course, due to the heavy falling off in traffic and the endeavor of the railways to economize. On the basis of four persons being dependent on each wage earner, it shows that over one-third of a million of people have been deprived of their regular means of support. The class of employes showing the greatest decrease are trackmen, the decrease for this class being 29,443, or 16·34 per cent.; the next largest decrease is 19,890, or 18·91 per cent. for laborers and other unclassified employes. The decrease in employes assigned to general administration was 3,635, or 10·27 per cent.; in employes assigned to maintenance of way and structures 40,841, or 15·94 per cent.; in employes assigned to maintenance of equipment 23,490, or 13·38 per cent.; and in employes assigned to conducting transportation 32,023, or 8·05 per cent. Localized, the largest decrease is in Group VI, 26,168, or 15·36 per cent., and Group III comes second with a decrease of 20,680, or 14·99 per cent. A new feature in this report is a table giving a comparative statement of the average daily compensation of the various classes of railway employes for 1892, 1893, and 1894. For 1894 the average daily compensation was for general officers, $9.71; other officers, $5.75; general office clerks, $2.34; station agents, $1.75; other station men, $1.63; engine men, $3.61; firemen, $2.03; conductors, $3.04; other trainmen, $1.89; machinists, $2.21; carpenters, $2.09; other shopmen, $1.69; section foremen, $1.71; other trackmen, $1.18; switchmen, flagmen, and watchmen, $1.75; telegraph operators and dispatchers, $1.93; and employes of floating equipment, $1.97.

CAPITALIZATION AND VALUATION OF RAILWAY PROPERTY.

The total amount of reported railway capital on June 30, 1894, was $10,796,473,813, or $62,951 per mile of line. This is an increase in the amount outstanding during the year of $290,233,403. The amount of capi-

tal stock was $4,834,075,659, of which $4,103,584,166 was common stock and $730,491,493 was preferred stock. The funded debt was $5,356,583,019, classified as follows: Bonds, $4,598,931,754; miscellaneous obligations, $456,277,380; income bonds, $242,408,681; and equipment trust obligations, $68,970,204. The amount of current liabilities was $695,815,135. The amount of railway securities held by the railways as an investment was $1,544,058,670, a decrease during the year of $18,963,563.

The amount of stock paying no dividend was $3,066,150,094, or 63·43 per cent. of the total amount. Of the stock paying dividends, 4·31 per cent. of the total stock paid from 4 to 5 per cent.; 10·12 per cent. paid from 5 to 6 per cent.; 5·12 per cent. paid from 6 to 7 per cent.; and 5·42 per cent. paid from 7 to 8 per cent. The total amount of dividends was $95,575,976, or an average rate on the dividend-paying stock of 5·41 per cent. The amount of bonds paying no interest was $650,573,789, or 14·17 per cent. The amount of miscellaneous obligations paying no interest was $53,426,264, or 11·71 per cent., and the amount of income bonds paying no interest was $210,757,554, or 86·94 per cent.

PUBLIC SERVICE.

The number of passengers carried was 619,688,109, an increase over the previous year of 26,127,587. This increase is almost wholly in groups III and VI, and was occasioned by the World's Fair travel. The passenger mileage was 14,289,445,893. The average number of passengers in a train was 44, and the average distance traveled by each passenger was 23·06 miles. The passenger mileage per mile of line, which indicates the density of passenger traffic, was 81,333, a slight decrease as compared with the previous report. There was a large decrease in freight traffic, the number of tons carried being 638,186 553, as against 745,119,482 in 1893, a decrease of 106,933,929 tons. The ton mileage was 80,335,104,702, a decrease of 13,253,007,131 from the previous year, and the ton miles per mile of line decreased from 551,239 in 1893 to 457,352 in 1894, a decrease in density of traffic of 93,980 ton miles; the average number of tons in a train was 179·80, a decrease of 4·17 tons, showing a decrease of economy in the use of freight equipment. The average haul of one ton was 125·88 miles.

EARNINGS AND EXPENSES.

The gross earnings of the railways for the year ending June 30, 1894, were $1,073,361,797, a decrease as compared with the previous year of $147,390,077, or 12·07 per cent. Passenger revenue decreased $16,142,258, or 5·35 per cent. and the revenue from freight traffic decreased $129,562,948, or 15·63 per cent. The amount of operating expenses was $731,414,322, a decrease of $96,506,977, or 11·68 per cent. The largest per cent. of decrease was in the operating expenses assigned to maintenance of way and structures and to maintenance of equipment, which show, respectively, a decrease of 15·12 and 17·52 per cent. The net earnings were $341,947,475, a decrease of $50,883,100 as compared with the previous year. The income derived from sources outside of operations was $142,816,805. The amount of fixed charges and other deductions from income was $429,008,310, leaving a net income of $55,755,970 available for dividends, a decrease as compared with the previous year of nearly 50·00 per cent. The amount of dividend paid was $95,575,976, a decrease of only $5,358,909 from the amount paid the previous year. The fact that nearly the normal amount of dividends was paid notwithstanding the great decrease in income available for them, and that the payment of the amount stated entailed a deficit from the operations of the year of $45,912,044, is suggestive. The revenue derived from the carrying of passengers was $285,349,558, or 26·58 per cent. of gross earnings, and the revenue derived from freight traffic was $699,490,913, or 65·16 per cent. of gross earnings.

ACCIDENTS.

During the year 1,823 railway employes were killed and 23,422 were injured, as compared with 2,727 killed and 31,729 injured in 1893. This marked decrease in casualty is in part due to the decrease in the number of men employed, and the decrease in the volume of business handled. The increased use of automatic appliances on railway equipment also may have rendered railway employment less dangerous and it may be that the grade of efficiency of employes has been raised.

The number of passengers killed was 334, an increase of 25, and the number injured was 3,304, a decrease of 195. Of the total number of fatal casualties to railway employes, 251 were due to coupling and uncoupling cars, 439 to falling from trains and engines, 50 to overhead obstructions, 145 to collisions, 108 to derailments, and the balance to various other causes not easily classified. To show the ratio of casualty it may be stated that 1 employe was killed out of every 428 in service and one injured out of every 33 employed. The trainmen perform the most dangerous service, 1 out of every 156 employed having been killed and 1 out of every 13 having been injured.

The ratio of casualty to passengers is in striking contrast to that of railway employes, 1 passenger having been killed out of each 1,912,618 carried, or for each 44,108,228 miles traveled, and 1 injured out of each 204,348 carried, or for each 4,709,771 miles traveled. A distribution of accidents to the territorial groups exhibits the diversity in the relative safety of railway employment and of railway travel in the different sections of the country.

CONCLUSION.

In concluding the report the statistician renews the recommendations made in previous reports in regard to the desirability of requiring annual reports from express companies; corporations, companies and persons owning rolling stock used in insterstate commerce, corporations, companies and persons owning depot property, stock yards, and elevators used by interstate carriers, and from carriers by water that compete with railways for traffic. Reference is also made to the question of requiring railways to report freight earnings by commodities. On account of the present depressed financial condition of railways, it has been decided to let this matter rest another year, although there is no question as to the desirability of such reports.

THE PHILADELPHIA AND READING COAL STORAGE PLANTS.

AT the June 15 meeting of the Engineers' Club of Philadelphia, Mr. William D. Beatty read the paper of the evening on the above subject. He stated that in order to provide for the demands of the coal trade, it has been found necessary to store coal in large quantities, in order to be ready for emergencies. The mines, as a rule, work only part of a week, and the further possibility of strikes, flooding of the collieries, blockades and various other causes, make it necessary to have a large supply on hand to meet the demands which may be made.

There are two general methods of coal storage: first the Hillside system, generally situated in the mining regions; and second, what may be termed the Level Floor system, generally located at or near the shipping points.

In the Hillside system, large bins are constructed on the slope of a hill, and a dumping track led along the top of the slope. The coal is dropped from the cars on the dumping track and rolls down the hill till stopped by the front of the bins. From the front of the bin a series of plank run back horizontally till they strike the slope of the hill, thus helping to arrest the coal and forming the beginning of the coal pile.

It is generally reloaded by an underground chain conveyor. This conveyor runs along the whole front of the storage plant and is operated by a rope drive. The coal is led into the conveyor trough by men with short lengths of sheet iron, and the conveyor thus carries it to a central hopper. Here another conveyor picks it up and carries it up an inclined plane to a tower, where it is screened and loaded into cars. Both the Schuylkill Haven and the Mahanoy City plants of the Reading Company are operated on this system.

The Schuylkill Haven plant was first operated by dump cars running back into the coal piles and then forward to a reloader track on a wharf constructed at the foot of the slope. From the edge of the wharf the coal was dropped through a screen and chute into the cars. This system is still used at Schuylkill Haven in connection with the later one.

The second, or level floor system, is well illustrated by the present plant at Port Richmond, Philadelphia, and the new plant now being constructed there on the Dodge Coal Storage system. The latter occupies about fifteen acres in the neighborhood of the present coal piers, and will consist of six piles of coal, two of 20,000 tons each, two of 30,000 tons each, and two of 40,000 tons each, making a storage capacity of 180,000 tons.

In this system the coal is stored by a chain conveyor, carried by a braced truss, constituting a trimming machine or trimmer. The apparatus for reloading consists of a pivoted ground conveyor with a flighted chain, an inclined plane carrying troughs for lifting the coal and a tower for screening and delivering to the cars. Generally, in this system, two trimmers and one reloader constitute a group, but in this case the two groups are each composed of three trimmers and two reloaders. There are thus six trimmers and four reloaders with inclines and screening towers used in the operation of this plant.

The trimmers span the coal piles at an angle of 27°, which is about the natural angle for coal in large quantities. The diameters of the coal piles are 232·4, 265·4 and 291·4 feet, and their altitudes are respectively 59·2, 67·7 and 74·4 feet.

The coal to be stored is run in on the dump track and dropped into a hopper. The hopper pit consists of a steel tank embedded in brick masonry and incloses the lower end of the conveyor trough. Above this, timber joists and planking, lined with sheet iron, form the hopper. Through a small door in the hopper controlled by an outside lever, the coal drops into the conveyor trough, where it is picked up by the flights on the chain and carried to its position in the pile. This position is determined by a sliding sheet 12 inches wide, which winds on a drum at the foot of the trimmer and forms the bottom of the conveyor trough. This sheet is worked by hand gearing, and its upper end is thus made to follow the receding apex of the coal pile, continually feeding the pile from the apex, and further allowing the coal to drop but a few inches. The conveyor chain having deposited its coal runs onto a sprocket wheel at the head of the trimmer, then back along the top on guide angles supported by steel frames bolted to the trimmer, to another tower at the foot, whence it runs vertically to the hopper pit and up the trimmer again.

When the coal is wanted for shipment, the reloader is moved to the edge of the coal pile and the chain set in motion. The flights on the chain then pick up the coal and carry it up the incline to chutes leading to shaking screens in the tower where it is screened and loaded into the cars. By means of a screw and lever, the shaft on the reloader, carrying the head sprocket wheel, may be moved forward or back, thus keeping the chain always at the proper tension.

The conveyor chain travels on the wearing plate to the foot of the incline, then up one side of the incline in a trough to a sprocket wheel on the head shaft in the screening tower, thence down the other inclined trough and around the other side of the reloader to the starting point. This conveyor chain is continuous over both reloader and incline, thus saving one dump with its consequent chance of breakage. It is guided by horizontal wheels at the short end of the reloader, and by holding-down wheels at the point of junction of the horizontal and incline, thus keeping the flights in direct contact with the coal. On both the trimmer and the reloader there is a guard over the chain, which serves still further to prevent the flights mounting the coal at any point.

Two wire ropes pass over spools on a hollow vertical shaft at this point and run back under the incline, one to the lever controlling the reloading drums, and the other to the lever controlling the chain movement. The man stationed on the platform thus has absolute control of the reloader and is in the best position for directing its movements.

The screens are of the shaking type and are double, the top one separating the sizes, the lower one taking out the dirt. The mesh of the top screens in the different towers varies according to the size of coal handled, but the screens themselves may be changed in a short time. They are suspended by wrought iron links and worked by eccentrics on a shaft connected by chain belting with main shaft in such a way that the oscillation of the screens takes place whenever the reloader chain is working; the top screen leads directly to the long chute, and coal passing over this screen is loaded into cars on the first track. Cars on both tracks can be loaded at the same time.

The power plant, operated by four independent Buckeye engines of 100 horse power each, was then described.

The other conveyor systems of the Philadelphia and Reading Railroad at Fairmount Avenue and Ninth Street Station, Philadelphia, were also briefly described, and the author closed by stating that the new plant has a nominal capacity of three tons a minute; but the experience of similar plants has been that including delays from breakdowns, stoppage to get out the dust, delay in shifting, and the usual troubles that occur in any large plant, 1,000–1,400 tons lifted, and the same amount dumped, constitute a fair day's work. The higher figures are for the later plants constructed on this system, and there is every reason to believe that the Richmond plant will at least equal, if not exceed, those figures; but even taking the low estimate, there will be a large saving in the cost of handling over present methods when the new plant goes into operation. Besides that it furnishes its own car-haul, reducing the locomotive service to a minimum, and by the continuity of the reloading system, and by having a very small drop for the coal at transfer points, reduces the waste from breakage to a very small amount. There will also be a large saving in fuel, but the plan of burning screenings may of course be applied to other power plants as well, and is not essential to this system.

Figuring on past records of cost, and allowing a fair estimate for the working capacity of a plant, it is expected that a saving of $35,000 or $40,000 a year in the cost of handling will result from the operations of the new plant.

DEFENSES AGAINST TORPEDOES.

IN the last three wars of importance, the Chilean, Brazilian, and Chino-Japanese, the automobile torpedo has played an important part. For a long time the naval architects of Europe have been devoting their energies to the building of fast torpedo boats, and the perfection of the torpedo itself, for the lesson of the Blanco Encalada, which was sunk in Caldera harbor, by torpedo cruisers, and the sinking of the Aquidaban, on the coast of Brazil, was not lost upon them, while the very recent destruction wrought upon the Chinese fleet in the harbor of Wei-Hai-Wei by the Japanese torpedo flotilla has evidently spurred on our Congress to order three new torpedo boats. The principal defenses against torpedoes which war vessels now possess are the search light and rapid-fire gun, and the torpedo net. The value of the rapid-fire gun for keeping the torpedo boat at a distance is admitted, but soon after the net was adopted the torpedo was equipped with powerful cutters which cut the net and allowed the torpedo to pass through. Tests were made at Newport in 1893, with various nets, but the Destroyer was removed so soon that no comparisons can be made from the results thus far obtained.

Dr. G. H. Jones, of London, has devised a new protection for war vessels. This consists of a solid casing of steel, an eighth of an inch or more in thickness, which is much more manageable than the crinoline now employed, as it can be lowered from the deck and worked by the engines. It can be raised above the water line, so as not to impede the ship's speed. It forms, when all the shields are in position, a complete outer skin with an intervening cushion of water, which is sufficient to secure the hull from serious injury.

Sir E. J. Reed says: "These net defenses are assuredly much inferior to the sheet steel defense, especially as regards the relative quickness and efficiency of bringing them into and out of position."

The adoption of the crinoline nets in our navy has been greatly delayed, but this may not be disadvantageous, if we secure a preferable system.

TESTING THE NEW MAXIM GUN.

IT is a much disputed point whether the inventor of an effective instrument of war is a benefactor or an enemy of mankind. It is true, however, that the final perfection of the science of killing means the end of war. Among the engines of destruction the Maxim gun holds the foremost place. The little instrument, which resembles a toy, weighs but 25 pounds, so that a regiment of infantry could be equipped with them. A thousand men could each fire 600 shots per minute, so that the entire regiment could fire 36,000,000 shots per hour, each bullet being capable of piercing 40 inches of oak. If even a small percentage of the bullets did their deadly work, war on a large scale would be impossible and armies would cease to meet. The cost of an hour's shooting with Maxim guns would be $1,440,000 for a regiment. The Maxim gun was first fired in the Sierra Leone campaign by Sir Francis de Wintar. It was also used by Henry M. Stanley in his travels. The total weight of the gun has not been less than 40 pounds heretofore.

A very successful test of the new Maxim gun for the use of infantry took place at the Sandy Hook Proving Ground June 8, before the Ordnance Board, under the direction of James Huber, the expert of the Maxim-Nordenfelt Company. The result of the test was eminently satisfactory in every way, and it is likely that the Board will advise the government to buy some of the guns. The test was largely a matter of form, as the gun has been adopted for a long time in other countries, though not in the improved form which was exhibited. The gun weighed 25 pounds, or 45 pounds when packed in its case with additional parts of the mechanism. In action it is mounted upon a tripod and consists of a single barrel attached to a metallic box which contains the rather complicated machinery. The ammunition is 0·303 caliber and is fed to the gun by belts which hold 100 cartridges each. The bullets are propelled by 38 grains of smokeless powder. The cartridges are exploded by a trigger arranged in a handle similar to that of an ordinary revolver. As long as the trigger is held back the gun will fire automatically as long as ammunition is supplied. When the trigger is released the firing ceases. The maximum number of shots which can be fired is

650 per minute. In continuous automatic rapid firing the gun would last for 50,000 rounds at the rate of 600 per minute. In the heavier guns the barrel is cooled by water, but this is not feasible in the light infantry gun. Of course this high rate of speed in the light guns could not be kept up for any great length of time without renewing some of the parts. The gun is entirely automatic in its action after the first shot has been fired. The recoil from the exploded cartridge gives the barrel, which has a rear attachment, a backward motion. The recoiling motion is limited to about an inch, as a crank comes in contact with the breech casing, causing it to rotate and strike a buffer spring which returns it into firing position. A crank also works the breech lock. The cartridges are fed into the gun by means of the belt which passes through feed blocks. The recoil of the barrel from the discharge of the first cartridge inserts the next charge from the belt, raises the breech lock, cocks the hammer and fires, extracts and ejects the shells while the succeeding charge is being brought into position.

The test began by general firing at a flag 500 yards distant, the test being for rapidity and not accuracy. Single and bunch shots were made and then a volley of 50 shots were made in 5⅘ seconds. The expert was the only person who could make the gun fire one shot and stop. The next test was to determine the time necessary to unlimber the gun and get it into action. In less than 58 seconds from the giving of the word of command the expert had the gun in position and was firing at the rate of 500 shots per minute. The report from the gun is neither very loud nor very sharp, but when a number of shots are fired in rapid succession the noise is continuous and even the members of the Ordnance Board found it necessary to put cotton in their ears. The next test was to determine the time required to take apart the firing mechanism and insert the extra set carried in a knapsack. It was found to be 26⅘ seconds. Changing the barrel between two shots took 1 minute 12½ seconds. The other tests were made with blank cartridges and with good cartridges mixed with bad ones. The object of this was to determine whether the gun would eject the bad cartridges and prevent them from stopping the firing. The turning of a small lever quickly removed the dead cartridge and the firing was not disturbed. In a few days the gun will be tested for accuracy, speed and range.

The gun will prove of special value in a mountainous country, where a few guns well placed would wipe out an army. One hundred men armed with the gun could mow down ten thousand cavalrymen with ease. The possibilities of the machine seem unlimited and its effectiveness is well summed up by a military man who witnessed the test. "It is the most deadly instrument of war I have ever seen. I have been told it was only a toy, whereas the accuracy and reliability are simply appalling." Each bullet will pierce the body of six men and its muzzle can be moved like the end of a garden hose.

THE REDUCTION OF THE RARER METALS FROM THEIR OXIDES.*

By Professor W. C. ROBERTS-AUSTEN, C.B., F.R.S.

MY communication can hardly be dignified by the name of a paper, but I thought, as the question of the reduction of the rarer metals from their oxides was one which was assuming very great importance, that it might interest the members of the society if I briefly showed them the methods by which this reduction can be effected.

When a metal is separated from a state of chemical combination it is said to be "reduced," and the process of separation is termed "reduction." For centuries the main agent employed for this purpose was either carbon or the gas carbonic oxide which is produced by its partial oxidation of carbon. Carbon has been used for the reduction of metallic oxides from times of which we have no written history, but the early metallurgists also availed themselves of a complex series of reactions which take place when metallic oxides are heated with metallic sulphides, without, however, understanding the nature of the mutual action of these substances on each other. Copper, for instance, must have been so separated from its ores without the direct action of carbon as a reducing agent from very early times, but carbon is still the agent by which reduction is effected in that vast metallurgical appliance, the blast furnace, used for smelting iron.

There are, however, many metallic oxides which will not part with their oxygen to either carbon or carbonic oxide. Alumina is an instance; its reduction by carbon can only be effected at a very high temperature, aided by the tearing effect of the electric current.

At the very high temperatures at which carbon may be vaporized, some 3,600° C., the reducing action of carbon vapor is probably energetic.

The history of the gradual introduction of other reducing agents is very interesting, but it will only be incidentally touched upon in order to make the nature of modern operations clearer than it otherwise would be.

At the beginning of the century, it became evident that metals might be used at high temperatures as reducing agents. Thus, in 1809, Davy, Gay-Lussac, and Thenard obtained the metals of the alkalies, and it was soon found that metallic potassium and sodium was a powerful weapon for separating oxygen from other metals. It often happened that the chloride was operated upon with the alkali metal; thus Berzelius obtained the metal yttrium, in the form of a gray powder, by heating its chloride with potassium.

Thus to take an important case, Wohler obtained metallic aluminum in 1822 as a gray powder by the action of potassium on aluminum chloride; and he afterward, in 1854, obtained it as a white, compact metal, unoxidizable in air, and acted on with difficulty by acids.

Mosander (1839) obtained metallic lanthanum and cerium by heating their chlorides with potassium and sodium respectively. Marignac was the first to prepare metallic didymium by heating its chloride with potassium. Or, to take another case: Wohler obtained crystalline chromium by igniting a mixture of anhydrous chromic chloride with finely divided zinc and sodium and potassium at the boiling point of zinc. Fremy also prepared crystalline chromium by the action of the vapor of sodium on anhydrous chromic chloride in a stream of hydrogen. Uranium is another metal which was separated by the aid of sodium; for, in 1841, Peligot ignited oxide of uranium UO_2 with charcoal in a stream of chlorine. He thus obtained volatile uranium tetrachloride, UCl_4, which, when heated with sodium, gave metallic uranium as a gray metal.

In 1863, indium was discovered in the Freiberg zinc blendes by Reich and Richter. It is best prepared by fusing the oxide with sodium as Winkler describes (Journ. Pract. Chem., cii, 273).

I hope at an early day to find time to deal fully with the history of the use of certain metals for the reduction of the oxides of the rarer metals; at present I would only refer to a very interesting paper by H. F. Keller,* who points out that Beketoff used aluminum for the reduction of potassium hydroxide. There can be no question that the cheapening of magnesium and aluminum will have a great influence in metallurgical operations conducted with a view to the extraction of the rarer metals from their oxides, and, as Keller states, Clemens Winkler, of Freiberg, has made a systematic investigation of the reducing action of magnesium upon oxides, while Seubert and Schmidt have conducted a similar investigation as to its action on chlorides.

Among the very early work in this direction on a practical scale must be mentioned that of Green and Wahl, whose patent is dated February 11, 1893 (No. 82). They obtained manganese and 'manganese alloys free from carbon, and this freedom from carbon is a point of the utmost importance. Manganese can be reduced from its oxides by the action of carbon and carbonic oxide, but the manganese so obtained always contains carbon, and when it becomes a question of the addition of manganese to a bath of molten steel, the simultaneous introduction of carbon may be a matter of great moment, as a few hundredths of one per cent. of carbon, in certain varieties of steel, is not to be lightly considered.

At a soiree of the Royal Society last year, Mr. Vautin exhibited some very interesting specimens of the rarer metals, which, aided by Mr. Picard, he had himself extracted mainly from their oxides by the use of finely divided aluminum—granulated aluminum, that is—which is obtained by vigorously stirring molten aluminum, while it is passing from the fluid to the solid state. Many of the specimens obtained by Mr. Vautin are exhibited to-night. I have obtained certain other specimens, and have employed them in the course of a recently conducted research.

There are certain experiments connected with the reduction of oxides by aluminum which it may interest you to see. I will therefore describe them.

In this little furnace there is a small crucible, which contains oxide of chromium and aluminum. The temperature is being raised to a point which we have very carefully measured; it is 1,015° C. I might have arranged the experiment with a thermo junction plunged into the mixed mass of aluminum and oxide of chromium, and you would have seen that as soon as a temperature of 1,015° is reached, the aluminum reacts on the metallic chromium. You will see a slight evolution of heat, light and smoke, and left behind in the crucible will be a little button of chromium. The reaction takes place comparatively quietly, but I think you will be able to see it. It requires a certain initial temperature for the aluminum to act on the oxide of chromium, and in this case that temperature is 1,015°.

[The reaction took place quietly, but a shower of sparks was projected from the crucible.]

We will break open the crucible presently, and there will be a little button of chromium left behind.

Now I will perform another experiment. I will take a little oxide of lead and metallic aluminum. Oxide of lead is very easily reduced; oxide of chromium is very difficult to reduce, as you have already seen. Oxide of lead in two minutes will be reduced with something approaching explosion. It is not at all an easy experiment to arrange, in fact it is very difficult; if you make the charge too large, you will blow the furnace to atoms, as we have done on many occasions. The difficulty is to produce a sufficient effect to satisfy you, perfectly free from any risk of danger [explosion took place like a rifle shot], and I am glad to say we have succeeded. The thermal conditions are all in our favor in this experiment; the aluminum reacts with great readiness on oxide of lead, and resents having so easy a task to perform, and expresses itself in a loud manner.

If you take, instead of oxide of lead, litharge which has been melted and ground up, the reaction is smaller, and explodes very much like a squib. When it is a case of a very difficult reducible oxide, the reaction takes place in a much more gentle manner. You may have variations from violent explosions, which will shiver the furnace, to the slow, gradual action of some of the more difficult oxidizable materials.

I now come to another totally different method of obtaining the rarer metals from their oxides, and the development of this method we owe to the distinguished French chemist, M. Moissan. He has pointed out that metallurgists have recently employed currents of high tension for the electrolysis of metallic compounds. The new method of preparing aluminum and magnesium are cases in point. The heat furnished by the electric arc can, moreover, be used in the reduction by carbon of certain oxides which have hitherto been considered to be irreducible. The great merit of Moissan's work consists in the fact that he has separated the heat action of the arc from the electrolytic action. He makes the heat reverberate on to the substance to be reduced, and by the use of currents of 400 amperes and 60 volts, he has given us a remarkable series of metals, usually, however, associated with carbon.

You almost always get carbides of the metals by this method. By placing oxide of uranium U_3O_8 in the electrical furnace, and passing a current of 450 amperes and 60 volts, Moissan obtained uranium containing 5 to 13 per cent. of carbon. From oxide of manganese, using 300 amperes and 60 volts, he obtained carbides of manganese containing 6 to 14 per cent. of carbon.

From chromium oxide Cr_2O_3, using 350 amperes or 50 volts, or even less, he obtained carbides of chromium containing 8·6 to 12·85 per cent of carbon. Zircon, when treated in the electrical furnace, using 360 amperes and 60 volts, yields either carbon, free zirconium or a carbide containing 4 to 5 per cent. of carbon, according to whether you take a small or a large supply of zircon to reduce. Again, tungsten from tungsten acid, using 350 amperes and 70 volts, you get either carbon, free tungsten or carbides, with it may be as much as 18 per cent. of carbon; but you can easily get tungsten carbon free by melting the carbide with excess of oxide.

Molybdenum is obtained by calcining molybdate of ammonia, using 350 amperes and 70 volts; you get a very hard carbide, containing about 9·88 per cent. of carbon. Oxide of vanadium is obtained by calcining a salt of vanadium. You get carbides rich in carbon, containing 17 to 25 per cent. of carbon. In that way he has given us practically all the rare metals.

I cannot do better than project on the screen the interior of the furnace, not, however, using it for the reduction of metallic oxides, because if I did that, you would practically see nothing unless you waited for some twenty minutes. I prefer to melt up some chromium, and we will project the image of the fluid mass on the screen. Chromium is a very difficult thing to melt. Over a hole in the cover of the furnace is a mirror, and a lens so arranged that the light coming up will be reflected on the mirror and thrown on the screen. You now see the poles and the base of the furnace. You are looking down into the furnace as if you were standing over it. The chromium is hanging a little to the side, but it will gradually melt down. The arc is not passing straight from pole to pole, but is deflected down by a magnet.

You can measure the temperature in this way, by detaching a piece of the carbon pole and dropping it quickly in water. You thus find out how much heat is transferred to the water and in that way you can estimate the temperature. Subsequently you can so determine the temperature which has been attained in the furnace itself. Speaking from previous results, I know the temperature in the furnace before you now cannot be less than 2,500° C., and probably it is a little higher.

I will now melt some wrought iron nails, which you will see will run down very soon.

[The experiment was then performed.]

I was right in insisting upon the fact that I have not dignified this brief communication by the title of a "Paper," but the experiments are so very beautiful that I could not refrain from showing them to the members.

Of the uses of the metals, now that we have them, it is impossible to say very much, but I need only to remind you of the extraordinary importance in armor plates and projectiles of the introduction of the metal chromium or nickel in small quantities to show that these must have an important future. With apologies for the brevity of this communication, that is my case.

DISCUSSION.

Mr. C. T. J. Vautin said he was glad of the opportunity of referring to the reduction of oxides by means of heat generated by electric energy, and could not do so without referring to Siemens. Siemens, as was stated in every text book, had described an electric furnace in which one pole was at the bottom and the other at the top, and with that furnace he witnessed in Melbourne, some ten years ago, the production of nearly every one of the carbides, or combinations of metals in carbon, which the illustrious French chemist Moissan had since produced. It was knowing what had been done in a quiet way by a gentleman who, he regretted to say, never published anything at all, Mr. Newbury, with whom he was fortunate in being associated, and after Mr. Moissan started his work he determined himself, if possible, to try and produce some of the metals free from carbon. These results were obtained to a great extent in consequence of being able to obtain aluminum in a finely divided form, and this was only done after several mechanical means had been tried and failed.

It was through Mr. Pickard's energy and research that they were able to obtain aluminum in a form most suited for reduction. So far as chromium was concerned, very large quantities were now being daily produced in Germany, as much as 4 or 5 cwt. at one casting, containing as little as ¼ per cent. of aluminum and not ½ per cent. of silicon. It was hoped that even that small quantity of silicon would be reduced by getting purer magnesia to work with. They were now producing alloys of calcium and iron containing 26 per cent. of calcium; and with these alloys experiments were being made for the purpose of desulphurizing iron; and from results which had been communicated to him, though not from his own experiments, he believed there might be some commercial application for such an alloy.

Referring once more to the splendid work of M. Moissan, he had the pleasure in Paris of looking at a number of his products, and the only thing which struck him there as being against the electrolytic method was its great cost as compared with the method of reduction by means of aluminum, which could now be obtained at as low a price as 3 marks per kilo—upward of 90 per cent. as it was produced at the Nordhausen works. Aluminum reduced with the greatest ease sodic oxide, calcic oxide and barium oxide. On the other hand, by no method he had heard of could they induce sodium to reduce alumina, and he thought it was doubtful whether potassium reduced alumina per se. On the other hand, the oxides of potassium and sodium could be reduced with the greatest ease by means of aluminum. There were some curious facts in connection with these reductions which were hardly fitted for that evening's discussion, but he hoped to have an opportunity some other time of bringing them forward.

Mr. Roger Wallace said he should like to say a few words in praise of the work that Mr. Roberts-Austen had been doing in connection with the rarer metals. The new use which had been pointed out for aluminum, in the reduction of other metals, was a factor of very great importance in the future of metallurgy.

With regard to the manufacture of aluminum in this country, he was pleased to say that the British Aluminum Company were now about to place this industry in

* Read before the Society of Arts, London, May, 1895.—From the Journal of the Society.

* Journal of the American Chemical Society, Dec., 1874, p. 883

its proper position, as far as Great Britain was concerned.

In the past, aluminum had been manufactured in this country by the chemical processes, but those processes had been altogether surpassed by the electrical process. The last he heard of chemical processes was when Mr. Vautin had produced, with very great industry and research, a sulphide of aluminum. He hoped for great things from that, but up to the present, he had not heard that Mr. Vautin had been able to reduce that sulphide. The company he had mentioned would soon be able to manufacture aluminum in Great Britain in the same way as it was produced in Nordhausen, and probably better, because, having the bauxite mines in Ireland and water power in Scotland, they would have every natural facility for success. In fact, they would be giving a new industry to Scotland, and also to Ireland, in the manufacture of aluminum from bauxite. He was glad to hear that Professor Roberts-Austen had a new use for aluminum, and felt that this furnace had a great future before it. Every one who had to do with chemistry knew that there was a very large future in the application of metals which, up to the present, had hardly been used at all. They saw it in the incandescent gas lighting, and in alloys of various metals, and this last use would probably be of very great importance. They knew that one of the great drawbacks to the use of aluminum had been its want of tensile strength, but there was little doubt that the addition of a very small percentage of some of these rarer metals, which had hitherto been beyond practical use, would enormously increase its tensile strength.

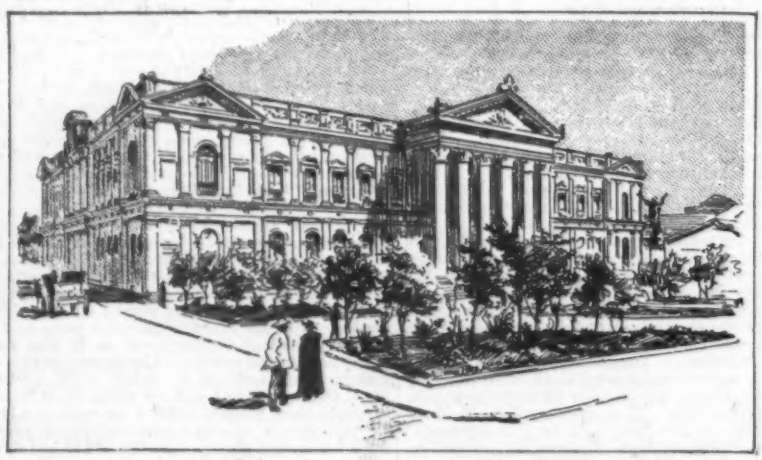
Professor Roberts-Austen said he had not specially dealt with all the beautiful specimens on the table, but had only taken up two at random, the magnificent mass of manganese carbon free and the equally fine fragment of a larger mass of chromium which he handed to the chairman as perhaps the most remarkable metallurgical specimen he had ever seen, both of which were produced by Mr. Vautin. On the table were also carbon-free tungsten, the only mass he had ever seen, uranium and some molybdenum which Mr. Pickard produced at the mint with him. There could be no question that a most important field was opening, and the cheapening of aluminum, to which Mr. Wallace referred, could not fail to play a most important part in metallurgy, by enabling them to get these rarer metals, and to add them to masses of their common associates, the effect of which was, in many cases, most remarkable. For instance, take the case of titanium, that would be most useful.

When the naval architects met in that room very recently, reference was made to the difficulty in the use of aluminum for torpedo boats on account of the boats corroding on the line between wind and water. He knew an instance where a yacht was built for a French proprietor who was very well pleased with it until he moored it, with an iron chain to an iron post, to which post was also moored a boat sheathed with copper. The result was that a gigantic battery was established, and the aluminum yacht was found to be dissolving away.

The addition of 0·2 per cent. of titanium increased the durability of such a metal as aluminum when subject to the solvent action of salt water. It was impossible to say what might happen when they had studied the properties of alloys containing minute quantities of the rarer metals. He hardly dared mention their uses in connection with electricity; "platinoid" and "manganive" had already attracted attention, and it was impossible to say what valuable results might be obtained.

THE CHILEAN HALL OF CONGRESS.

A TELEGRAM from Santiago announces that the Chilean Hall of Congress in the capital was totally destroyed by fire on May 18, the disaster being attributed to incendiarism. Santiago, the "city of rich people," as it is called on the west coast of South America, is famous for its fine streets and handsome public buildings. A third of a century ago (writes a correspondent) the church of the "Compania de Jesus," situated at the back of the cathedral, caught fire while mass was being celebrated, and about 2,000 ladies lost their lives. The behavior of the priests on this occasion is said to have given the death blow to priestcraft in Chile. The church was not allowed to be rebuilt, but on its site was erected a hall for the Chilean Legislative Assembly, a building some 60 ft. in height and 300 ft. in length. It was profusely adorned with marble in its three large halls, one of which was used as the Chamber of Deputies, another as the Chamber of Senators, and the third for swearing in the president of the republic. One portion of the building was used as offices for the engineers of the Public Works Department.—London Daily Graphic.



THE CHILEAN CONGRESS HALL AT SANTIAGO, WHICH HAS BEEN TOTALLY DESTROYED BY FIRE.

A NEW METHOD OF COMPUTING.

By E. W. SCRIPTURE, Yale University.

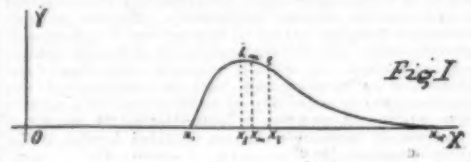
SUPPOSE that you have measured the heights of a group of twenty-five men, what do you do with the results, which vary, more or less, from one another? Let us take a case that occurs all over the country every year. Each graduating class of every college and school has the heights of its members measured. For the sake of comparison with preceding and succeeding classes, the individual heights are generally "averaged." Thus the "average" height of the class of '93 is said to have been, say, 66 inches, that of '94, 67 inches, etc.

But a great deal of dissatisfaction arises with this "average" height. The presence of a single very tall or very short man upsets the whole result.

Let us take a class of ten men, of the heights 65, 64, 65, 66, 66, 67, 65, 66, 76, 66, the average height is 67 inches.

Now let us take another class, with the heights 66, 65, 68, 67, 69, 68, 66, 67, 66, 67. Every man is taller by an inch than the corresponding man in the previous class, but there is no extraordinarily tall man there. Yet the average is 66·9, or a little less than that of the other class.

Now it is evident that the one very tall man ought not to outweigh the influence of the other nine men. It is apparent that the average is a very unsatisfactory representative value in such a case.



What is especially striking is that every man influences the result in direct proportion to his deviation from the average. For example, in the first class the man of 65 inches influences the average by the amount $\frac{67-65}{10}$ = 0·2 of an inch, while the tall man influences it by $\frac{76-67}{10}$ = 0·9 of an inch. This does not seem quite fair.

This difficulty and unfairness can be removed by treating every man alike, by allowing all measurements to affect the result to the same degree. This is done by the use of the median instead of the average.

The median was first considered as a representative value by Laplace, who treated some of its properties from a theoretical point of view. Fechner believed that it could be used for statistical purposes. He explained a crude method of computing it. But aside from a few isolated attempts, mainly as curiosities, the median was never practically used in computation until I introduced it into my laboratory in the year 1896. During the year 1894 fully 100,000 measurements of the most varied kinds were adjusted on the basis of the median in place of or in addition to the average.

On the strength of this experience I have published (Studies from the Yale Psychological Laboratory, Vol. II) an analytical and practical consideration of the median and its properties.

What is the median? It is the middle value in a set of numbers. Suppose the numbers to be arranged in order of size; then, beginning at the smallest or at the largest, count them off until you come to the middle one. For example, the first class mentioned above would run 64, 65, 65, 66, 66, 66, 67, 67, 68, 76. The middle value for ten measurements would be between the fifth and the sixth. In this case, both are the same and the median is 66.

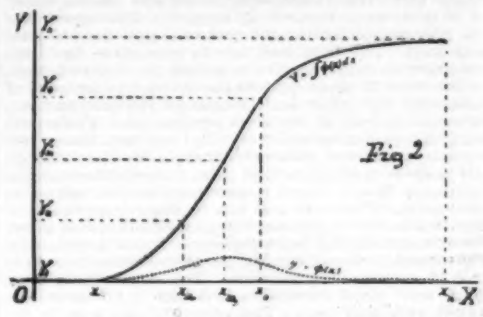
How much influence does the tall man have? Merely that of one man; as long as he is above 66 inches, it makes no difference how tall he is. In like manner every value influences the median merely as one value above or below. As tall men or short men are added, the median goes up or down according to the number of men added, not according to the number of inches added.

For the second class we had 65, 66, 66, 66, 67, 67, 67, 68, 68, 69. The median is 67.

The median for n values is that one which is the $\frac{n+1}{2}$th in order of size from either extreme. For five values it will be the third, for thirty the 15½th, etc. It is not necessary to write the values in order of size; they can generally be selected by the eye. For short sets of values the whole process can be done mentally.

Persons familiar with the science of measurement will realize the theoretical advantage of the value of middle probability, the median X_m, over the value of mean area, the average X_ξ, for all unsymmetrical curves of error (Fig. 1). When the curve is symmetrical, the median and the average are the same. The case is very striking when the integral curve of probability (Fig. 2) is considered. The values X_γ and X_λ are the over and under quartiles proposed by Galton for use instead of the mean variation in statistical measurements. Of the use of these values I do not approve.

Experience has shown that the median is a far better value than the average in all statistical and psychological measurements and in all measurements where psychological factors come into play, e. g., in the so-called errors of observation of astronomical and physical measurements. Strangely enough such phenomena as the fluctuating price of corn or the varying records of the barometer are better represented by the median than by the average. Of course, in cases where the results are reckoned by the number of units and not by the number of things, e. g., meat by the pound, debts by the dollar, etc., the average is the proper value.



ELECTRIC CURRENTS.

PROF. GEORGE FORBES, F.R.S., delivered recently lectures at the Royal Institution on "Alternating and Interrupted Electric Currents." He said that in the course of the work in which he had been engaged during the past few years, he had had occasion to find some simple means of expression to convey to his own mind, as well as to the minds of others, clear ideas about more or less obscure electrical phenomena, and the analogies thus wrought out he intended to set forth in these lectures. Professor Dewar had told him that his listeners expected him to talk much of what he had been doing at Niagara. He was not responsible for that anticipation, and was sorry to disappoint them to a great extent, for he was going to speak more about the problems of submarine telegraphy, and in the experiments he intended to show had been assisted by several friends, more especially Mr. Swinton and Dr. Muirhead. Submarine telegraphy has hitherto been much wrapped up, he said, in the obscurity of mathematical symbols, and he hoped to make some of its more recondite phenomena intelligible to every one.

Professor Forbes then explained how a submarine cable has to be charged and discharged like a Leyden jar, the conducting wire forming the inner coating and the sea the outer coating. In early times electricity was spoken of as analogous to the flow of water through pipes, and in some respects an exceedingly good analogy it is. The pressure of the water symbolizes the electromotive force, and the friction of the pipe the resistance. The pressure may be supposed to be furnished by a centrifugal pump at the central station. Instead of using up the whole of the energy of the centrifugal pump in the pipe, we might have a very large pipe, with a little one at its farther end in which there is great friction, and that is analogous to the principle of electric lighting; or instead of a little pipe at the far end we may place a turbine there, and that would be analogous to an electro-motor to drive machinery.

There are, however, more obscure electrical phenomena to which the analogy of water flowing through pipes does not apply, and especially is this the case when alternating currents are used. In mechanics likewise we have obscure phenomena not easily explicable, as in those presented by the action of the gyrostat, the principles of which it takes a considerable amount of thought to make clear. Again, suppose a revolving wheel, A, Fig. 1, to have an endless chain,

FIG. 1.

B, banging on a groove in the circumference of the wheel, and turning with it, then let the loop of the chain be pressed at K out of the perpendicular and made to assume the form shown in the cut, it behaves like a rigid body, and when left to itself does not rapidly fall back into a perpendicular loop. No intelligent mechanic would have expected such a result beforehand, and still less would he have expected the following: A, Fig. 2, is a wheel of cardboard with a number of little weights fixed round it near its circumference. The wheel is made to revolve round its central axis, W. If now the top of the revolving wheel be bent over as at K, in the side view shown at B, Fig. 2, it will remain bent over so long as the wheel is driven at a particular rapidity, and a much greater speed has to be applied before it shows a tendency to assume the vertical.

These mechanical phenomena depend upon flexibility, but they are not readily explicable. There is something analogous to them in electrical phenomena.

After showing how, with rapid alternations and high potentials of hundreds of thousands of volts, he could light an incandescent lamp, and that the conditions were no longer analogous to the flow of water through pipes, he said that one of the simplest means of considering electromotive force was that of a vertical string, to which a twist was applied at one end, and acting against a resisting frictional force; on this principle he made an artificial line, by which several of the phenomena of an Atlantic cable could be imitated. The principle of construction may be represented by Fig. 3, in which the thread above A, nearly up to the vanes, was in a long tube of glycerine, to put on resistance; the vanes gave a twist to the thread by means of an air blast applied to them whenever the "key" of this contrivance was pressed for the sending of signals; to render the signals visible to the auditory after passing through the thread, a mirror was mounted at the lower end of the apparatus, and a reflected spot of

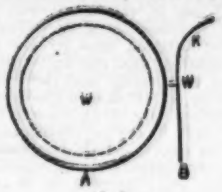


FIG. 2.

light projected upon the screen. B, Fig. 3, shows the electrical apparatus it imitated in its results. By means of an artificial Atlantic cable lent by Dr. Muirhead, and some real Atlantic telegraph instruments, signals were projected upon the screen, then the same signals were sent through Professor Forbes' twisted thread by means of air blasts, and they were identical at the receiving end, even to the way in which one impulse pushes on beyond its predecessor when sending some letters of the alphabet, without the spot of light first returning to zero. Professor Forbes' described Dr. Muirhead's artificial cables of sheets of tinfoil separated by paraffined paper; they were originally invented and practically used in research by the late Mr. Cromwell Varley, but have some more recent modifications by Dr. Muirhead. Mr. Varley publicly exhibited the originals in a Friday evening lecture at the Royal Institution many years ago, and with them showed the time taken in transmitting an electrical impulse along an imaginary submarine cable from England to Gibraltar, Alexandria, Bombay, Ceylon, and so on to Melbourne, with stations at the different places.

Professor Forbes also described the "curb key" and other parts of the Atlantic telegraph signaling apparatus. He said that the application of the curb was analogous to a man cracking a whip; if he threw forward the cord, he could make a crack, but if he drew the whip sharply back just before the crack came, he could make a much sharper noise. In the curb key a current in one direction is quickly followed by another in the opposite direction. He showed that by his twisted thread apparatus he could imitate the real signals given by the curb key.

He said in continuation of the argument that although mechanical analogies are a great help to understanding the phenomena resulting from the action of alternating and interrupted currents, he wished it nevertheless to be understood that too much should not be drawn from these mechanical analogies, or they would lead to wrong deductions. The example he had

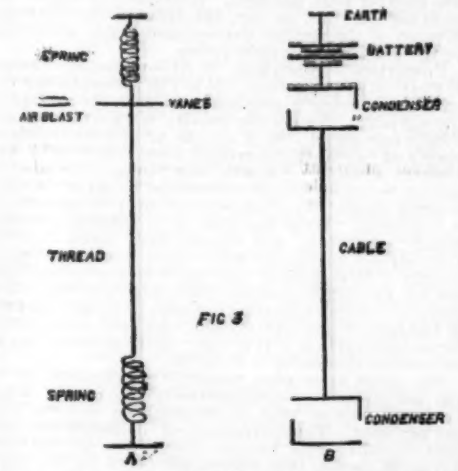


FIG 3

shown of an artificial cable of twisted string formed a very good mechanical analogy; there was but one defect in it, and that was that with it the resistance varies with the current, instead of with the square of the current. This defect is of but little importance, for the signals through the artificial line are indistinguishable from those through a real cable, to those in the habit of reading off messages in the work of submarine telegraphy. Clerk Maxwell, in his great work on electrical subjects, evidently dealt all through with mechanical analogies, although he does not say so; one proof is in his use of the words "electrical displacement."

The lecturer then drew attention to the following table, referring to the mechanical analogies of which he made use:

Electrical Measurements.	Mechanical Analogies.
Pressure	Twisting force.
Current	Rotary velocity.
Resistance	Friction.
Charge	Twist.
Capacity	Twist with unit force.
Self-induction	Momentum.
Dielectric strength	Breaking strain.

Examples of assumed units.

Assumed	One volt—1 cr. at 1 in. radius. One ampere—one revolution per second.
Deduced	One coulomb—one revolution. One farad—one revolution per cr. One henry—a cylinder 1 in. radius, weighting 69 cr.

He said that he did not always keep to the particular units of the foregoing table, but used different units for each case, and these in the table were not employed when dealing with submarine cables. Professor Forbes next spoke of the work of Oersted, and how in the solitude of his chamber he had worked out the principles of nearly all the electric and magnetic phenomena with which we are now acquainted. Then he spoke of the labors of Faraday and his researches on self and mutual induction, the analogue or mechanical equivalent of which he said is momentum. In illustration of this, he took a rod of glass, B, as in the accompanying cut, Fig. 4, with a fly wheel, C, at its lower end, and a driving wheel, A, at its upper end. When he turned this arrangement slowly, and tried to stop it suddenly, the fly wheel tried to carry the motion farther, and this is analogous to self-induction. When he tried to produce an alternating rotation, the fly wheel put in considerable resistance, just as when an alternating current is sent through a Gramme ring such as he had on the table connected with an incandescent lamp.

Faraday's invention of the induction coil, or of the transformer, as it is now sometimes called, gave a great help to electric light engineering, enabling a current of one pressure to be transformed into a current of another pressure. It has, however, been infinitely more useful in electric power engineering. Over the work going on in connection with the electrical installation at Niagara Falls, nothing had struck him more than the great differences in the character of the electric supply demanded by manufacturers far and near for their special purposes. There would have been great difficulty in meeting these demands with a continuous current, which Lord Kelvin stands now almost alone in advocating for the purpose. The more the work progressed at Niagara, the more satisfied were they that they had adopted the alternating current.

FIG. 4.

He had been trying to reduce the capacity of the cables as much as possible, and to an unprecedented extent to reduce the frequency of alternations. Both these steps have proved advantageous. He had had a difficulty in convincing people of the danger of suddenly breaking a circuit of these induced currents. They had been misled by their previous experience, and broke them suddenly to reduce the fire at the switch, without being aware that they were endangering the whole system. Among the mechanical analogues the lecturer gave of this was the sudden stopping of the arrangement shown in Fig. 1, when the momentum of the fly wheel broke the glass rod. In electrical systems like those of which he had been speaking, gradually increasing resistance should be put in, so that the current cannot be stopped suddenly. He did not wish it to be understood that by a system of mechanical analogues he wished to get rid of mathematics, but that he looked upon the former as a help to the latter.

ON DROPS.*

By J. B. HANNAY.

THE formation of drops, their variation with the density and chemical composition of the liquids forming them and their variation with temperature and frequency, have been the subject of investigation by several chemists and physicists, but without reaching unanimity as to the definition of a drop, or the cause of its parting from the flowing liquid.

The author referred to the first investigation to define a standard drop and discover the laws regulating its foundation by Guthrie, according to whom a full normal drop could not exist, all drops being more or less imperfect. He found that the quicker the rate of dropping the larger the drop, and this he explained by supposing that when a drop parts from a solid support a portion of the root or stem of the drop is torn back by the attraction of the solid from which the drop falls.

This conclusion the author tested in 1878, by making a liquid drop from itself: (1) by ascertaining if there is variation in the size of drops into which a smooth running stream divides as it falls when the rate is varied; (2) by allowing a liquid to drop from a column of its own substance retained in position by walls to which it does not adhere, for instance, mercury dropped from a clean dry glass tube. Both experiments showed the same variation of size with rate as when dropped from a solid. The theory of a portion being torn back by adhesion was therefore disproved, and the conclusion arrived at was that the neck of a drop forms a tube through which liquid is flowing into the drop, and after a drop begins to fall it receives an accession of liquid during the time taken to complete the rupture of the neck, this accession varying directly as the flow. Thus a conclusion diametrically opposite to Guthrie's is reached, viz., that a true drop is one of which the rate is infinitely slow, and all other drops are greater than a true drop, and not less, as Guthrie concluded. The weight of a true or normal drop is found by determining the difference of weight with rate and reducing the rate to zero, which then gives the weight of a drop at the moment it begins to part. Experiments with solutions of potassium iodide, potassium nitrate, potassium sulphate and magnesium sulphate showed that the size of drops has no connection with the viscosity or internal friction of the solution. Thus, while potassium iodide increases the rate of flow or diminishes internal friction and magnesium sulphate has an opposite effect, yet potassium iodide solution of twice normal strength and magnesium sulphate solution of normal strength form almost identical drops. The conditions under which a drop parts from its root or stem were studied by causing water to drop through oil of different densities and viscosities, and drops of oil were also allowed to rise upward through water. In this way the influence of viscosity was eliminated.

The size of the normal drop of distilled water in olive oil was 0·4096 c. c. When dropped at the rate of ten seconds to a drop the volume is increased to 0·5611 c. c., while drops formed from a cylinder of water arranged so as to eliminate the effects of gravity is 0·5470 c. c., which shows that the determining factor in the formation and parting of a drop is contractility. Gravity acts by pulling the drop out of its spherical form; the contractile force of the liquid will not permit of this form but at once starts a constriction which shears through the neck and detaches a drop. The author confirms Tate's observation made in 1864 that "The weight of the drop is sensibly proportional to the diameter of the tube from which it falls; hence the force which holds the drop is a surface one, and not one of general cohesion. It is only an extremely thin envelope of the drop which influences its size and shape." This fact was proved by dropping water at 20° C. into benzine vapor at 47° C., so that the benzine vapor quickly condensed and formed a thin envelope on the water drop. The weight of the normal drop of water being 0·1081 c. c.; when dropped in benzine vapor it was reduced to 0·0449 c. c. Traube has shown that in the case of certain organic alcohols and acids the volume of the drops is proportional to their rise in height in the capillary tube. It was found that in the case of the saline solutions already referred to the size of the drop is in close agreement with the capillary constant. The author concludes that the weight of a normal or infinitely slow drop is controlled by its surface tension or contractility, while when dropping in practice it is modified by the rate of flow, by its gravity, the viscosity of the medium in which it drops, and by its rate of fall, all of which affects the lifetime of the closing neck.

* Abstract of a paper read before the Royal Society of Edinburgh, on May 6, 1895.

[FROM NATURE.]

PROFESSOR LOTHAR MEYER.

JULIUS LOTHAR MEYER was born at Varel in Oldenburg, on August 19, 1830. After completing his school course in the Gymnasium, he studied in the University of Zurich from 1851 to 1853, then at Wurzburg from 1853 to 1854; from Wurzburg he went to Heidelberg, where he remained till the autumn of 1856, and from thence he migrated to Konigsberg, where he remained until Easter 1858. Meyer's original intention was to devote himself to medicine, and he graduated as Doctor in Medicine at Wurzburg on February 24, 1854. At Heidelberg he came under the influence of Bunsen, and his work became more and more chemical. At Konigsberg his studies were devoted mainly to mathematical physics, under the guidance of F. Neumann. In 1858 he took the degree of Ph.D. at Breslau; and on February 21, 1859, he received leave to teach chemistry and physics. From 1859 to 1866 Meyer was in charge of the chemical laboratory of the Physiological Institute at Breslau. In 1866 he was called to the Royal Prussian Forstakademie at Eberswalde, where he remained until 1868, when he went to the Polytechnikum at Carlsruhe. In 1876 Prof. Fittig was called from Tubingen to the University of Strassburg, and Lothar Meyer was appointed to fill the vacancy at Tubingen.

He had nearly completed twenty years work at Tubingen when the summons came. Cerebral apoplexy stopped his labors, on April 12 of this year; and, plotzlich, sanft, und schmerzlos, he passed.

It was while teaching chemistry and physics at Breslau that Meyer published the first edition of the work on which his reputation as a philosophical chemist chiefly rests. "Die Modernen Theorien der Chemie" appeared in 1864. A second edition was published in 1872; and since that time have appeared a third, fourth, and fifth edition. At the time of his death Meyer was engaged in the preparation of a sixth edition, which he intended to publish in three, more or less independent, parts. An English translation of the fifth edition, by Messrs. Bedson and Williams, appeared in 1888. In 1883 Profs. Meyer and Seubert recalculated the atomic weights of the elements from the original data, and laid all chemists under a debt of gratitude by publishing their results, under the title "Die Atomgewichte der Elemente aus den Originalzahlen neu berechnet."

Lothar Meyer was one of the earliest investigators of the relations between the properties and the atomic weights of the elements. In the first edition of his "Modernen Theorien" (published in 1864) he traced relations between the atomic weights and the chemical values of the elements; and in December 1869 appeared a memoir by him entitled "Die Natur der chemischen Elemente als Funktion ihrer Atomgewichte," wherein he arranged the elements in order of atomic weights, in a single table, and indicated the periodic character of the dependence of properties on atomic weights.

The clear enunciation, and the application in detail, of the most far-reaching generalization that has been made in chemistry since the work of Dalton, must, undoubtedly, be credited to that great chemist Mendeleeff, but, nevertheless, a perusal of the controversy between Mendeleeff and Meyer shows, I think, that Meyer arrived at the fundamental conception of the periodic law independently of Mendeleeff. Those who are interested in such controversies will find papers by Mendeleeff and Meyer in Berichte xiii, pp. 259, 1796, 2043 [1880].

In his discourse to the German Chemical Society on

May 29, 1868, "Ueber den Vortrag der unorganischen Chemie nach dem naturlichen Systeme der Elemente," Meyer quotes the words which Laurent had used fifty years before concerning organic chemistry, and applies them to the teaching of inorganic chemistry at the present time: Que l'arbitraire y règne sans partage. If these words can be applied to the teaching of inorganic and general chemistry to-day, how much more fully and literally were they applicable at the time when the first edition of Meyer's "Die Modernen Theorien" appeared thirty years ago! That book has probably done more than any other publication within the twenty years after 1864 to advance the study of comparative chemistry; its influence on the conception of chemistry as an accurate and orderly body of facts and principles has been very great, and has been wholly good. The labor bestowed on the preparation of the first edition of the "Modern Theories" must have been immense. The author speaks in his preface of rewriting the MS. three times. It is true that thirty years ago physical chemistry was practically non-existent, that the facts of organic chemistry could be mastered and held by a man with an ordinary memory, and that one might be a chemist without first being a mathematical physicist. But it is also true that the facts of inorganic chemistry had not been co-ordinated by the luminous conception of the periodic law, that there was a lack of clearness in the notions of most chemists about the structure of organic compounds—for Kekuie had not yet made his famous ride on the top of the Clapham omnibus—and that the many isolated facts regarding the influence of temperature, time, and the masses of the reacting bodies on chemical changes had not been gathered together and illuminated by the law of mass action and the conceptions arising from the applications of this law. It was then that "Die Modernen Theorien" appeared; and at once a flood of light was thrown on the whole domain of chemical science. Old problems were made clear, and new problems were suggested. Chemistry entered on its modern phase.

As the study of comparative chemistry progressed—a study which was introduced by the enunciation of the periodic law—it became necessary to know with accuracy the analytical bases whereon rested the values accepted for the atomic weights of the elements. Hence Lothar Meyer was induced to devote a large amount of labor to the somewhat thankless task of recalculating these values; the result of this work, carried out with the help of his colleague Prof. Seubert, appeared in 1883. This work received additional value from the fact that it appeared almost at the same time as Clarke's "Recalculation of the Atomic Weights." Every worker in this department has the data of all previous workers brought to his hand, and presented in the most manageable form.

Besides these two treatises bearing on general chemistry, Lothar Meyer was an investigator in the sphere of experimental chemistry. He has published memoirs of subjects in almost every branch of the science; on the atomic weight of beryllium, on determinations of vapor densities, on the combustion of carbon monoxide, on the preparation of hydriodic acid, on the transpiration of gases, on various organic compounds, and on other matters.

A great chemist has passed away from us; his work remains, and that work will ever be held in remembrance.

M. M. PATTISON MUIR.

TERRESTRIAL HELIUM (?)

ON A GAS SHOWING THE SPECTRUM OF HELIUM, THE REPUTED CAUSE OF D_3, ONE OF THE LINES IN THE SPECTRUM OF THE SUN'S CHROMOSPHERE.*

IN the course of investigations on argon, some clew was sought for, which would lead to the selection of one out of the almost innumerable compounds with which chemists are acquainted, with which to attempt to induce argon to combine. A paper by W. F. Hillebrand, "On the Occurrence of Nitrogen in Uraninite, etc." (Bulletin of the United States Geological Survey, No. 78, p. 43), to which Mr. Miers kindly directed my attention, gave the desired clew. In spite of Hillebrand's positive proof that the gas he obtained by boiling various samples of uraninite with weak sulphuric acid was nitrogen (p. 55)—such as formation of ammonia on sparking with hydrogen, analysis of the platinichloride, vacuum tube spectrum, etc.—I was skeptical enough to doubt that any compound of nitrogen, when boiled with acid, would yield free nitrogen. The result has justified the skepticism.

The mineral employed was cleveite, essentially a uranate of lead, containing rare earths. On boiling with weak sulphuric acid, a considerable quantity of gas was evolved. It was sparked with oxygen over soda, so as to free it from nitrogen and all known gaseous bodies except argon; there was but little contraction; the nitrogen removed may well have been introduced from air during this preliminary experiment. The gas was transferred over mercury, and the oxygen absorbed by potassium pyrogallate; the gas was removed, washed with a trace of boiled water, and dried by admitting a little sulphuric acid into the tube containing it, which stood over mercury. The total amount was some 20 c. c.

Several vacuum tubes were filled with this gas, and the spectrum was examined, the spectrum of argon being thrown simultaneously into the spectroscope. It was at once evident that a new gas was present along with argon.

Fortunately, the agon tube was one which had been made to try whether magnesium poles would free the argon from all traces of nitrogen. This it did; but hydrogen was evolved from the magnesium, so that its spectrum was distinctly visible. Moreover, magnesium usually contains sodium, and the D line was also visible, though faintly, in the argon tube. The gas from cleveite also showed hydrogen lines dimly, probably through not having been filled with completely dried gas.

On comparing the two spectra, I noticed at once that while the hydrogen and argon lines in both tubes accurately coincided, a brilliant line in the yellow, in the cleveite gas, was nearly but not quite coincident with the sodium line, D, of the argon tube.

Mr. Crookes was so kind as to measure the wave length of this remarkably brilliant yellow line. It is 587·49 millionths of a millimeter, and is exactly coincident with the line, D_3, in the solar chromosphere, attributed to the solar element which has been named helium.

Mr. Crookes has kindly consented to make accurate measurements of the position of the lines in this spectrum, which he will publish, and I have placed at his disposal tubes containing the gas. I shall, therefore, here give only a general account of the appearance of the spectrum.

While the light emitted from a Plucker's tube charged with argon is bright crimson, when a strong current is passed through it, the light from the helium tube is brilliant golden yellow. With a feeble current the argon tube shows a blue-violet light, the helium tube a steely blue, and the yellow line is barely visible in the spectroscope. It appears to require a high temperature, therefore, to cause it to appear with full brilliancy, and it may be supposed to be part of the high temperature spectrum of helium.

The following table gives a qualitative comparison of the spectra in the argon * and in the helium tubes:

	Argon tube.	Helium tube.	
Red	1st triplet.	1st triplet.	Equal in intensity.
	2d pair.	2d pair.	" "
	Faint line.	Faint line.	" "
	Stronger line.	Stronger line.	" "
	Brilliant line.	Dull line.	Weak in helium.
	Strong line.	Very dim line.	
Red-orange	Moderate line.	Moderate line.	Equal in intensity.
	" "	" "	" "
	" "	" "	" "
Orange	Faint line.	Faint line.	" "
	Triplet.	Triplet.	" "
Orange-yellow	Pair.	Pair.	" "
Yellow	Absent.	Brilliant.	W = 587·49 (the helium line, D_3).
Green	7 lines.	7 lines.	Equal in intensity.
	5 lines.	5 lines.	" "
Green blue	Absent.	Faint.	In helium only.
	Absent.	Brilliant.	" "
Blue	Absent.	8 lines.	" "
Blue-violet	8 lines strong.	Barely visible, if indeed present at all.	
	2, fairly strong.	2, fairly strong.	Equal in intensity.
	Absent.	Bright line.	In helium only.
	Absent.	4 bright lines.	
Violet	Violet pair.	Violet pair.	Equal in intensity.
	Single line.	Single line.	" "
	Triplet.	Triplet.	" "
	Triplet.	Triplet.	" "
	Pair.	Pair.	" "

It is to be noticed that argon is present in the helium tube, and by the use of two coils the spectra could be made of equal intensity. But there are sixteen easily visible lines present in the helium tube only, of which one is the magnificent yellow, and there are two red lines strong in argon and three violet lines strong in argon, but barely visible and doubtful in the helium tube. This would imply that atmospheric argon contains a gas absent from the argon in the helium tube. It may be that this gas is the cause of the high density of argon, which would place its atomic weight higher than that of potassium.

It is idle to speculate on the properties of helium at such an early stage in the investigation; but I am now preparing fairly large quantities of the mixture, and hope to be able before long to give data respecting the density of the mixture, and to attempt the separation of argon from helium.

* Preliminary note by Professor William Ramsay, F.R.S. Presented at a meeting of the Royal Society, April 25, 1895. From Nature.

* The tube then used was the one with which Mr. Crookes' measurements of the argon spectrum were made. It contains absolutely pure atmospheric argon.

ON ARGON AND HELIUM.†

I HAVE examined the gas which is found inclosed in meteoric iron. The meteorite which I used was from Augusta County, Virginia, U.S.A., and had been examined by Professor Mallet. The analysis has been published in the American Journal of Science, July, 1871; it contains:

Fe	88·4
Ni	10·2
Co	0·4
P	0·3
C	0·2

besides traces of Cu, Sn, Mn, Cl, S, and SiO_2. We have obtained 45 c.c. of a gas, some per cent. of which disappeared on detonation with oxygen. The residue being submitted to electric sparks in presence of caustic soda underwent a slight contraction. The residue was dried with caustic soda, and I found, by means of the spectroscope, that it consists of argon, of which it shows all the characteristic marks.

We may also observe the yellow line of helium, and on comparing it with a sample of pure helium, the identity was certain. It does not coincide with the D lines of sodium.

It is interesting to find the presence of argon in a substance foreign to the earth, though it has not been recognized in the sun.

It must be remarked in conclusion that there are no lines except those of argon and helium.

I am still occupied with helium; its density is 3·88, and the ratio of the specific heats is 1·66, as with argon.

It is remarkable that the difference between the densities of argon and helium is 16, which is the case for the members of the first group and those of the second.

Helium is found in most of the minerals of the rare earths which I have examined. It is very curious that it has not been recognized earlier.—Comptes Rendus.

† Extract of a letter from Professor Ramsay to M. Berthelot.—Chem. News.

ACETYLENE.‡

By Dr. F. L. SLOCUM.

HISTORY.—Acetylene (C_2H_2) was first discovered and isolated by Davy§ in 1837. He obtained it from the black mass produced in the manufacture of potassium. In 1858, Perrot‖ produced acetylene gas by the action of the electric spark on the vapors of alcohol and ether. Quet¶ observed that the gas formed by electrolytic action on ethylene gas in alcohol was taken up by sub-chlorid of copper and chlorid of silver, forming a very high detonating compound. In 1858 and 1859, Berthelot made a much more thorough examination of acetylene and its compounds, and established its properties in general.

There are many ways of producing acetylene, such as passing hydrogen between the poles in an electric arc; by exposing marsh gas, or coal gas, to a very high heat or an electric spark, but up to within a recent period the most practical way of producing acetylene was by the incomplete combustion of coal gas, for example, where a Bunsen burner strikes back and burns inside the tube. The acetylene, which is always formed by the incomplete combustion of hydrocarbons, is, in this case, only partially burned, and can be collected in a solution of sub-chlorid of copper, with which it forms an insoluble compound—$C_2H_2Cu_2O$. This material, when dry, is very explosive and difficult of manipulation; hence, acetylene, up to the present time, has been very difficult to produce in quantity, in a pure state. In 1862, Woehler* produced calcium carbide by heating a mixture of lime, zinc, and carbon to a white heat. He found that the black mass formed would liberate gas when brought in contact with water. He tested this gas in the usual way, proved it to be acetylene, and promised, in a very short article which he wrote on the subject, that in the near future he would give a detailed analysis and full description of this method of producing acetylene; but Providence decided otherwise, as the doctor died shortly afterward, and never finished the work he had in mind. From that time until last year the production of acetylene, when wanted for experimental purposes, has been produced by the old method—the incomplete combustion of a hydrocarbon gas. In 1893, H. Moissan† produced calcium carbide, but did not make a thorough examination of the same. In 1894‡ he produced calcium carbide by the action of the electric furnace on lime and carbon. The examination and analysis showed that its composition was CaC_2. Moissan is, therefore, the real discoverer, after Woehler, and the first discoverer of the production of calcium carbide in a commercial way. Moissan has been experimenting for years with the high temperatures produced by the electric furnace, and has made many very valuable discoveries, especially the production of carbides of different elements, as, for example, he has lately produced a very pure carbide of aluminum, which, when brought in contact with water, produces marsh or natural gas ($C H_4$)—$Al_2 C_3 + 12 H_2O = 3 C H_4 + 2 Al_2 (OH_6)$. This is very interesting, as it is the first practical indication of the real sources of petroleum. The large amount of work that has been done with the high temperature of the electric arc shows that a whole series of carbides existed when higher temperatures were obtained than those within the present reach of human means, up to the time of practical operation of the electric furnace. In former ages, large masses of more or less pure oxides of different elements could have been brought in contact with carbon at very high temperatures, forming carbides. These carbides were deposited in the lower and heated measures of the earth's crusts, and, as they gradually cooled, water, in the form of steam, under enormous pressure, was brought in contact with them, producing many of the different hydrocarbons now found in nature. Moissan has lately made some nitrid compounds of different elements, which, when brought in contact with water, produced pure ammonia. These are mentioned especially to give an idea of the range of this class of compounds, if a certain temperature can be obtained and maintained in any quantity. There have been within the last eight months numerous articles in the various technical journals as to the cost of the production of acetylene, and the gas fraternity in general have been very much agitated by, at least, some of these articles, which would lead the reader to believe that acetylene was cheaper than daylight. Acetylene, or rather calcium carbide, has, as yet, not fulfilled the assertions of many of the articles written, and is not at present on the market at daylight prices.

Properties.—Acetylene (C_2H_2—molecular weight 25·94—C = 92·31 per cent.—H = 7·69 per cent.) is a colorless gas having a peculiar, disagreeable and penetrating odor. Its specific gravity is 0·91 observed and 0·89829 calculated. It is gas at all ordinary temperatures and pressures. Its critical point is at 37·05° C. and 1,000 lb. pressure. Above this temperature the gas cannot be liquefied, and is governed by the laws of permanent gases. At a temperature of 1° C. and 706 lb., it is a liquid. When liquefied it is mobile, colorless, highly refractory, and lighter than water, and is a very strong solvent of fats. One liter of acetylene weighs 1·16148 grains; one cubic foot weighs 507·5838 grains, or 0·07255 pound; 1,000 cubic feet weigh 72·55 pounds. It has a heating capacity of 11,923 heat units in Centigrade and kilo system. Its heat value, pound for pound (carbon = 1) is 1·48. Its heat value, volume for volume (hydrogen = 1) is 4·53.

The most interesting property of acetylene, to the gas manufacturer, is its extremely high candle power, being 240 candles, with a consumption of 5 cu. ft. of gas per hour. The comparison of its luminosity with that of other well known compounds, as made by Vivian B. Lewes, is as follows, all based on an equal consumption of gas, viz., 5 cu. ft. per hour:

	Candles.
Methane	5·2
Ethane	35·7
Propane	56·7
Ethylene	70·0
Butylene	123·0
Acetylene	240·0

Calcium carbide (Ca_2C), a bluish-black, solid crystalline, brittle mass, having a specific gravity of 2·22, can be heated to a red heat, in an atmosphere of nitrogen, without decomposition, but is immediately decomposed, when brought in contact with water, into calcium hydrate, and acetylene. The reaction is as follows:

$$Ca\ C_2 + 2H_2\ O = C_2H_2 + Ca\ (OH)_2.$$

As stated above, this interesting compound was first discovered by Woehler, and its practical production, by use of the electric furnace, by Moissan. There has been a great deal written in the last few months in

‡ A paper read before the Western Gas Association, Pittsburg, May, 1895.

§ Davy, Liebig's Annalen, Vol. 92, p. 114.

‖ Perrot, Liebig's Annalen, Vol. 106, p. 114.

¶ Quet, Liebig's Annalen, Vol. 109, p. 116.

* Woehler, Liebig's Annalen, Vol. 124, p. 220.

† H. Moissan, Comptes Rendus, Vol. 115, p. 1031; Comptes Rendus, Vol. 116, p. 1222.

‡ H. Moissan, Comptes Rendus, Vol. 118, p. 501.

regard to the cost of calcium carbide. Willson has put the price at $15 per ton, others at $40, and still others at $100, and so on. In this country and in Europe, there have been formed numerous companies, both large and small, to promote and further the industry of gas manufacture by means of calcium carbide, but as yet there is but very little calcium carbide on the market. The writer is interested in a business where we have an electric current of sufficient voltage and amperage, and a furnace of sufficient capacity, to produce calcium carbide in very large quantities. We have given some time to the production of this material. We find that the arc works entirely on resistance, and that the mass, before combination and after, is almost non-conducting; therefore, the production of carbide must be exceptionally small for a given amount of current. Nearly all the calculations that have been published have been theoretical, and of little use in estimating the real cost of the manufacture of calcium carbide. The Aluminum-Industrie-Actiengesellschaft, in Neuhausen, Switzerland, who are exceptionally well located for the manufacture of this material, are advertising it at 5½c. per pound. This is 14¾c. per pound for acetylene contained therein. As acetylene weighs 72 55 lb. per 1,000 cu. ft., this would make it cost the consumer $6.20* per 1,000 cu. ft.

From our practical experience in the manufacture of calcium carbide in a large way, we believe this to be a fair selling price, giving an ordinarily fair manufacturer's profit. Assuming this to be the case, the acetylene question, so far as the gas manager is concerned for the use of enriching or illuminating, becomes of little interest. There is, however, one use to which acetylene can be put by the gas manager, even at its present price, which makes it of extreme interest to the manufacturer of any kind of gas for lighting purposes, throughout the whole civilized world, and that is its use as a light standard or unit. For the measurement of light it is apparently the perfect standard for a light unit. As the requirement for an absolute standard of light is a gas which can be produced always in a like state of purity, in all parts of the world, preferably by means of decomposition of a substance in the water, so that at a given temperature the gas will always contain a certain percentage of moisture. This gas must be a definite compound, and be composed of the illuminating principle itself. It can then be burned at a certain speed and height through a specific gravity tip burner, and thus always give, constantly and exactly, an even and constant amount of light per unit of time. Acetylene, manufactured from calcium carbide, fills each and all of these conditions. In a recent very interesting paper by Professor Lewes, he showed quite conclusively that acetylene was the luminous principle in all hydrocarbon flames. Therefore, only acetylene, when burned in its pure state, would be able to give a constant luminosity. The apparatus necessary for the production of sufficient acetylene, for light unit uses on the photometer, is very simple. All that is required is a small holder in which the gas is taken from the top, working in a tank in which it can be sunk entirely below the water level. A small enlargement is made on one side of the holder basin, passing to the bottom, and of sufficient size to allow a wire gauze holder about 2" in diameter to be passed to the bottom and under the holder. The amount of calcium carbide necessary is then wrapped in the wire gauze, pushed down under the surface of the water, and the acetylene gas allowed to escape for a few seconds, or until all the air is removed from the mass, and then it is passed to the bottom and turned underneath the holder and held there until the holder is sufficiently full. The holder is then allowed to stand until the temperature of the water is constant and near 15° C. The percentage of moisture in the gas has then become constant. The gas is burned under a given pressure, through a special tip, the same that is used for specific gravity determinations, by diffusion. The writer anticipated giving the results of tests with photometric measurements, in comparison with normal candles, but has been unable to do so, and reserves this for a future publication.

In regard to the future of calcium carbide: There seems to be little hope of its general use as a competitor of coal and water gas. Its chief uses will likely be in lighthouse work, isolated lighting plants, possibly in car service, in the use for light unit, and special purposes where other gas is not available, or where extremely high candle power gas is necessary and the present price is not prohibitory. It is going to be an industry that will gradually grow, and it is possible the production of carbide will become much cheaper than at present, although there is no indication of any great cheapening in its manufacture, from our present knowledge. Its use will likely be very extended in the general technical world; in fact, it is of far more interest in the numerous branches of organic chemistry than in the field of gas making.

In regard to its transportation in quantity: It is best shipped in cans, tightly sealed. There has been a company formed in Philadelphia to manufacture acetylene and compress it in cylinders in a liquid form. This seems very much like "carrying coals to Newcastle," as a ton of calcium carbide will yield over 750 pounds of acetylene, and it is certainly much more convenient and in much smaller space than if acetylene gas was compressed into cylinders. The cylinders would necessarily have to be about the same as those for the transportation of carbonic acid gas, as the critical point of the two gases lies at about the same temperature. It would, therefore, require about forty cylinders to transport the equivalent of one ton of calcium carbide, and the danger of explosions with liquefied acetylene would be very great. It is not a question of what to do with acetylene, or how to produce it, with the gas manager, but it is a question of "How cheap can I buy calcium carbide?" and as yet calcium carbide cannot be produced at a figure which would make it available for any ordinary uses in the manufacture of gas, and the state of the art does not indicate that it will for a long time to come.

[After the reading of this paper by Dr. Slocum, the room is darkened and experiments in acetylene are shown. The doctor is heartily applauded.]

Mr. Brown: I would like to ask him, "Does the furnace involve the use of fire around the crucible or do they rely upon a current to maintain the fusion in a heavily lined smelting furnace?"

Dr. Slocum: We have methods of using both, with fire around the furnace and without it, but the temperature around the furnace in cases of calcium carbide is only an auxiliary heat. It is not a melting heat. The lime and the carbon before the formation have a slight amount of conductivity, but it is very slight on account of the non-conductivity of the calcium. With respect to CaO, it is mixed in the mass, it being at least one-half, or nearly one-half; so there is practically no conductivity in the beginning. As soon as the calcium carbide is formed there is no conductivity to the mass, at that temperature, and there is no conductivity even when it is colder; consequently it works directly down unresisted, and if your lime and carbon are not there, it is not affected at all. You have got to work right down through, and you have got to take a bundle of the ordinary electric arc light carbons and work them down, to get any work out of the furnace at all, until you can pass down through all the material underneath; and then when you do get it formed it is exactly like slag and it is a great deal harder to handle than steel. Steel runs very much easier than slag; consequently you have got a slag, a nasty stuff, to handle, hard to get at, and it is hard to get the whole mass formed and handle it any reasonable way. That all costs when you cannot get it moved fast, and therefore the formation, if in large quantities, seems to be very difficult. In an electric furnace, as long as you are using your resistance the current is going through from the positive to the negative pole. If it does not heat the calcium carbide on its way and convert it, it is gone, and your theory is lost.

* The calculation of the cost of acetylene per thousand from this basis, does not appear to be correct. The proper figure is $10.70.—Ed. Progressive Age.

[N. Y. HERALD.]

THE DESCENT OF MAN.

PROF. EDWARD DRINKER COPE, of the University or Pennsylvania, traces nine ancestors of man back to unknown and unnamed fishes in the paleozoic age, in the light of investigations of modern science, largely his own, and also establishes the succession of types of man since his appearance as a creature of intelligence. No coherent account of the descent of man, understandable by ordinary minds, has heretofore been published, nor have the investigations of scientists been sufficiently advanced hitherto to be able to announce positively such descent. The words of Professor Cope may therefore be taken as the most important announcement of scientific discoveries of modern times.

Professor Cope has earned a world-wide reputation as a scientific scholar. He carries in his head, instantaneously ready for use at any time, and under any circumstances, a large vocabulary of Latin and Greek scientific names of species, hundreds of which he has coined and brought into general use. Wherever there is a scientific society in the world, Professor Cope's name is found in the list of honorary members, and on him have been bestowed the most honorable medals for scientific research. Owing to examinations of the craniums of thousands of mammals, existent and extinct, and his careful comparison of their dentition, he has been able to make the most profound discoveries on the origin and descent of man. He is the author of numerous and voluminous works, one of them as large as Webster's International Dictionary. After some preliminary talk, during which he expressed some disinclination to give out the results of his investigations in other than the regular scientific channels, he consented to speak freely regarding his discoveries and those of others, accepted as bearing on the descent and ascent of man.

MAN'S ORIGINAL ANCESTOR.

"When we speak of the ancestor of man," he said, "we refer to the animal in the preceding age which most nearly resembled man. The ancestor of this animal is the one in the age preceding it which most nearly resembled it in important particulars. This explanation is necessary because of the monstrosities in the way of views on the subject put forth by the clergy and laity on a matter concerning which they have given no intelligent study. These gentlemen would have us think that scientists would have us believe that a modern ape was somehow converted into a man. No scientific man has ever advanced such a theory.

"A million years ago, for instance, a modern man could not have existed on this earth, for the obvious reason that the race was not sufficiently advanced. The animals existing at that time were such as could maintain an existence on the earth as it was then. The highest type of animal then in existence was undoubtedly an ancestor of man. His skull had some of the characteristics of man. He may have walked on four feet, but his hind feet somewhat resembled the feet of men, and his forefeet somewhat resembled the hands of men. He may not have had beefsteaks for breakfast, but he was omnivorous, and his teeth and his stomach might have possibly handled a beefsteak. He undoubtedly had sufficient intelligence to appreciate a modern course dinner, if he could have got one.

"As the progenitor of the human race had powers of observation, he was familiar with the ancestor of the present horse, an animal with a hoof and two dew claws, smaller than the present beast of burden, but with sufficient characteristics of the horse to have nipped and digested the grass of that period. Had an ancestor of this ancestor had sufficient powers of observation, he might have noted the beginning of a remarkable retrogradation in nature, the exact opposite of evolution. He might possibly have noted a common ancestor, from which evolved the dog family on the one hand, and from which retrograded the bear family on the other hand. These statements should, I think, make simple the whole theme of evolution, the progress by which the earth, through cycles of time, grew from an inert mass into a beautiful habitation, on which the sunlight streamed until there was a prolific provision for the highest human intelligence."

THE ORDER OF SUCCESSION.

Professor Cope then continued and delineated the ancestors of man in the order of succession. He said:

"1. The anthropoid, or manlike ape. This mammal was an inhabitant of the neogene period. He was one of the simiidæ, or great apes, with the great toe opposable, in contradistinction to the hominidae, or human family, which succeeded him, having the great toe directed forward.

"2. The anthropoid, or manlike lemur. He was an inhabitant of the eocene period. He was one of the anaptomorphidae, a family of lemurs having anthropoid or manlike dentition. The lemurs are small animals, allied to the monkeys, with fox faces and large eyes. Types of them are still found in Madagascar.

"3. The pseudo or false lemurs, inhabitants of the eocene period and belonging to the family of adapidae. The false lemurs were a primitive branch of the ungulates, or hoofed animals in general. The adapidae were a family of quadrumana between the lemurs and the condylarthra, or primitive hoofed placental mammals.

"4. The lowest types of ungulates, or hoofed animals, come next, comprising the condylarthra, primitive hoofed placental animals, found in the Puerco beds belonging to the earliest eocene age, in Northwestern New Mexico. They were derived from the creodonta, primitive clawed placental mammals with carnivorous teeth, found in the earlier Laramie (Wyoming) cretaceous beds. From the condylarthra were descended all of the ungulates, while the creodonta were the ancestors of all the clawed mammals.

"5. The pantotheria, forms between the creodonts and carnivorous marsupials (mammals which carry immature young in pouches), come next. They were something like opossums, and have been found in the jurassic formations of the middle mesozoic age.

"6. Still lower and next in order are the protodonta, closely allied to carnivorous reptiles, found in the still older triassic formations of the mesozoic age. The protodonta were forms between the marsupials, or monotremes, and the theromorous reptiles.

"7. As we proceed further upward in the line of the ancestry of man, the next link of the chain is found in the theromorous reptiles of the permian, or closing, period of the carboniferous age and paleozoic area. Theromorous reptiles are those which agree in some respects with mammals.

"8. Next are the stegacephalous batrachians (primitive salamanders), found in the coal measures. They were roof-headed and are an extinct order.

"9. The paleozoic area had still lower forms of animal life, number nine in the chain of the ancestry of man. They form the last (or first) known ancestor, and belong to the fishes. I pause to inquire, which? Those fishes are as far up the line as science can glance at present. The link, though visible, is too obscure to detect which species of fishes should represent it. Science advances only so far as it has the facts. The facts end at this point and mere surmises are unsatisfactory to the investigating mind. But these fishes probably all arose from the type of sandlanes or amphioxus, 'a fish-like creature, two or three inches long, found in temperate seas, its body pointed at both ends, the lowest and most generalized of the vertebrates, having neither brain, skull, vertebrae nor red blood.'"

MAN'S COMPOSITE DESCENT.

Professor Cope paused at this point and smiled. He said: "Judging by the chain of animal life, man has inherited through cycles of time some of the characteristics of many of the forms now extinct. He has in his blood the traits of apes, the lemurs, the pseudo lemurs; the lowest types of ungulates or hoofed animals, the opossums or animals allied to them, the flesh-eating reptiles and of the batrachians or primitive salamanders, and lastly of fishes too remote to classify them."

"What about the beginnings of man as a creature of intelligence?" was asked.

"If we step from the anthropoid or manlike ape, or simiidae of the neocene period, to the first form of man on earth, we have a creature of but trifling intelligence in advance of his ancestral father. This first man was twofold as to materials and twofold as to localities. This statement differs from the Garden of Eden theory. The bones of this man have been found in Europe and in Java, and he is known as Neanderthal man, Homo Neanderthalensis. Neanderthal is a valley in Rhenish Prussia where the skulls of this man were found and from whence he derives his scientific name. He had the same characteristics of skeleton and dentition as the existing lowest races of men. In addition he had a transverse ridge across the inner side of the symphysis of the lower jaw above the genioglossal tuberosity, from which it is separated by a deep transverse valley. Nothing like this occurs in any existing race of homo sapiens or modern man.

THE NEANDERTHAL MAN.

"Virchow notes that the cranial capacities of the Neanderthal man match with those of the lowest types of men now in existence. The cranial capacities matched are those of a Nigrito of Andamans, with 950 cubic centimeters; an inhabitant of New Britain, with 880 centimeters; Nilgiri, India, 900 centimeters; New Ireland, with 970 centimeters; and of Abyssinia, with 975 centimeters. No trace of the bones of the Neanderthal man has been found on this continent. The skull found in the gold-bearing gravel of Calaveras County, Cal., was without a lower jaw, so its specific position cannot be determined. The cranium proper, however, does not resemble that of the older species. The same is true of the man of Sarasota Bay, Fla., and the man of the baths of Penon, near the city of Mexico, had the usual type of lower jaw. Neanderthal man is, therefore, still a myth in North America, but he has friends who are diligently looking for him in caves and elsewhere. He is very much wanted, and just one skeleton of him would please the friends of the late poet Bryant, in whose 'History of the United States' is a glaring picture of him, piercing the mastodon with spears. The mastodon has been extinct about ten thousand years, it is estimated, so the picture is on the line of Jules Verne.

MAN AND MASTODONS.

"Numerous skeletons of the mastodon are constantly being unearthed, but beyond doubt no one has discovered with such bones the bones of man. There is a considerable probability that man was contemporaneous with the Equus fauna of the West, which was contemporary with the Megalonyx—the sharp-clawed,

gigantic sloth—fauna of the East. But in the West man was not paleolithic, as some people have tried to make out, as he made smoothly ground pestles and mortars. This North American early man must have had some companions, such as the extinct genus of sloths Mylodon, the pug-nosed bear, four species of camels of the extinct genus of Holomeniscus—between the camels and llamas—a peccary, recent species of dogs—Canis—the pouched gopher or Thomys, three extinct species of horses and the hairy elephant.

"It would seem only necessary to say further that the ancestors of man and of all extinct species of animals disappeared by reason of the submergence of the land they occupied and other changes. When the re-elevation of this land took place, a higher type of animals appeared, which should explain the theme of evolution."

STREET TREES.

ONE can hardly think of a tree planted in the border of a city street without some feeling of pity. The air in which its leaves grow is polluted with dust and smoke, which impede their healthful action, and the soil in which it stands is often sterile, usually paved over, so as to prevent sufficient moisture from getting to its roots, and this aridity is intensified by sewers which hurry the water away as quickly as possible. In the majority of cases no attempt is made to protect it from horses which gnaw its bark, or insects which devour its foliage, and even if the tree survives these hardships, it will be mutilated by telegraph linemen or amateur surgeons who will lop off its limbs, and thus invite the attacks of various fungi which will soon carry decay to its heart. Of course, the very hardships to which a street tree is subjected ought to suggest the greatest care in selecting promising individuals of the species which have proved the most able to endure unconvenial surroundings, which means that only carefully grown nursery trees of the best form and habit should be planted in the most approved manner in the richest soil that can be secured. But, in spite of all that has been written on the subject, we rarely find that the original work of selecting and planting has been done in a way that is anything like satisfactory.

These things have been said over and over again, so that we feel like making an apology to readers for once more repeating such elementary truths. But what we have seen within a few days past gives evidence that instructions can hardly be given too frequently or too fully. Through a neighboring city and its suburbs for a distance of more than a dozen miles a macadamized pleasure drive has lately been constructed. Advertisements for proposals to plant the borders of this road with maples or poplars were made, and the contract was let to the lowest bidder, who agreed to furnish trees from ten to twelve feet high, to dig circular holes three feet in circumference and two and a half deep, to fill these holes with good loam and plant the trees properly in this fertile soil for eighty-five cents a tree. Of course it is not possible to buy good trees and plant them properly for that sum. As a matter of history, the trees planted for the city were of the required height and trunk diameter. A band of Italians dug holes of full contract dimensions, and then, in most cases, enough good soil to honestly fill them was dumped beside them. The trees were then distributed, one being laid by each hole, and it usually remained lying and drying in the sun for several hours, often for a whole day. These trees were mostly cottonwoods and white maple, both of which will endure a good deal of hard usage without dying outright. They were generally bare poles with two or three large prong-like roots a few inches long and no small roots whatever. They were set up in the mould, and this was trodden firmly about them, but they were left without any stakes or guards. Where the holes are made in the hard pan the first heavy rain saturated the soil in the tight basin, and it became in many cases as soft as porridge, so that the slightest touch would tilt over the trees, and, although they have only been planted a month, a large per cent. of them lean more or less from the perpendicular. Most of them are dead at the top, and are putting out a few leaves along the trunk and larger branches. If the season is not too dry, many of them will survive—that is they will not die outright, but will linger out a sickly existence. Of course, there is no hope that any considerable portion of them will ever develop into noble and uniform specimens befitting the stately character of this avenue.

The utterly disreputable character of this work from the very beginning is emphasized by half a dozen trees along this same boulevard, where the owner of the land received permission to do his own planting. He made excavations six feet square and three feet deep, and filled them in with good soil in the early autumn, heaping up this soil to allow for its settling. After a winter of freezing and thawing, this soil had become firm and compact. Norway maples, with well-formed heads, good roots and uniform size, were bought from a reputable nursery and properly planted the next spring. They were surrounded with a wire netting, and they have now passed through one trying summer and winter. This year they are making a vigorous growth, and stand as an object lesson to show what the street might have been if intelligent care had been bestowed in making and carrying out the original contract. It is never worth while to plant street trees at all unless they are planted in this way. The first essential quality of a good street tree is the beauty of health and vigor. It is better to have no trees at all than to have those which are doomed to disease and premature death.

Of course, in formal planting like this only one variety should be used. The beauty of a country roadside is enhanced by the diversity of its growth, where constant change of form and color gives ever renewed pleasure to the wayfarer. But when trees stand like a row of columns between parallel lines of buildings, the true formal and architectural effect can only be secured by continued repetition. It is this uniformity which makes an avenue of American elms so effective. It is not the beauty of a single tree which causes this charm, but it is the multiplied effect of a thousand units which combine to make this a long colonnade supporting its Gothic roof. Of course the American elm is not the only tree which can be used to advantage, for in a different way an avenue of stately tulip trees may be quite as beautiful, while a row of pin oaks would have an effect distinctly their own, but unexcelled in grace. If all these trees were mingled together the effect would be dissipated and lost, as there would be no continuous line extending through the whole vista to give it unity of expression and consisteney of purpose. This incongruity would be seen at once, and it would be exaggerated with each succeeding year, not only as the trees vary in rapidity of growth, but their peculiarities of form and size and expression would grow more striking and contradictory every year. The sum of the matter is that every city should plant its own trees as much as it should pave its own streets. The work, of course, should be superintended by experts, who, to do the best work, should have a municipal nursery, as the commissioners have in Washington, who grow the trees which they plant, and can arrange to have them in suitable quantities and of the proper form and size at the time when they are needed. An expert commission would take care to plant the trees in a sufficient quantity of good, well settled soil. They would set them far enough apart to give each tree an opportunity for its best development; they would water them and mulch them until firmly rooted; they would prune them properly and guard them carefully from all injury by man and beast, realizing that a healthy and vigorous tree is less liable to suffer from insects and disease than one which has been mutilated and enfeebled in any way. If we compare a street properly planted with another, along whose curb a row of spindling saplings from the woods have been carelessly set, we shall realize that the greater portion of the money which has been spent in planting street trees in this country has been worse than wasted.—Garden and Forest.

A HYBRID TOBACCO.

THE photograph of the very notable plant here figured Mr. Burbank sends from his garden in Santa

A CALIFORNIAN HYBRID TOBACCO.

Rosa, California. He describes it as a hybrid between Nicotiana colossea and N. wigandioides, and much finer than either parent. Evidently the plant is worth inquiring about, judging from its growth in a climate like that of California.—The Garden.

VITALITY OF SEEDS.*

THE duration of the vitality of seeds is perhaps the most important of the various phenomena of plant life, especially when considered in connection with the introduction into a country of the economic plants of other countries. It is a subject that has engaged attention from very early times, and the literature relating thereto is considerable. Much of this, however, is of a traditional and unpractical character; but even if we confine ourselves to the demonstrable or demonstrated, the subject is almost inexhaustible. There is such an infinity of variety in the behavior of seeds under different conditions, that it is impossible in a short account, such as this must be, to do more than convey a general idea of the subject. Perhaps the best way to treat the question, apart from technicalities, is to consider the vitality of seeds under ordinary and under extraordinary conditions. In the development and germination of seeds, there is, in a sense, usually a period of gestation and a period of incubation, as in oviparous organisms of the animal kingdom; and the duration of these periods is within definable limits, under ordinary conditions, though seeds do not exhibit the same fixity of time in regard to development and vitality as eggs. The embryo of a seed is the result of the impregnation of the female ovum in the ovary or young seed vessel, by the male element, generated in the anthers; and in the mature state this embryo may fill the whole space within the skin or testa of the seed, as in the bean and acorn; or it may be a comparatively minute body, as in wheat, maize and other cereals; the rest of the seed being filled with matter not incorporated in the embryo. The difference is one of degree in development. In the one case, the growing embryo has absorbed into its own system, as it were, before germination or the beginning of the growth of the embryo into a new plant, the whole of the nutrient material provided in the seed for reproduction; whereas, in the latter case, the process of absorption and utilization of the "albumen" or nutrient matter takes place after the seed is detached from the parent plant and during the earliest stage of growth of the new plant; so that the plant is nourished until it has formed organs capable of assimilating the food obtainable from the atmosphere and earth.

* From Nature.

Between these two extremes of development of the embryo or future plant, before organic connection with the parent ceases, there is every conceivable degree and variety; and, as will presently be explained with examples, some plants are viviparous, in the sense that the embryo commences active life before being severed from the parent, so that when this occurs the plant is in a position to draw its sustenance from unassimilated or inorganic materials.

Now it is a curious and unexplainable fact that certain seeds exhibiting the extremes of embryonal development, instanced in the bean and wheat, are equally retentive of their germinative power. The longevity, if it may be so called, of seeds is exemplified in "exalbuminous" seeds as well as in "albuminous" seeds of every degree. It should be mentioned, however, that the difference is not so much one of assimilation or development as of the earlier or later transfer of the nutrient matter of the seed to the embryo or plantlet. Assuming the perfect maturation of a seed, certain conditions are necessary to quicken its dormant vitality; and the two principal factors are heat and moisture, varying enormously in amount for different plants, and acting much more rapidly on some seeds than on others, even when the amount required is much the same.

Neither under natural nor under artificial conditions will some seeds retain their vitality more than one season; and all the resources of the accumulated experience of seed importers from distant countries are insufficient in some cases to maintain their vitality. It is not altogether because the interval between the dispersal and the germination of the seed, under ordinary conditions, is necessarily longer; but rather because in the one case the conditions under which a seed will germinate are much more restricted than in the other.

Let us now examine the natural conditions under which seeds are commonly produced and dispersed, in relation to the retention of their vitality; and we shall learn how much more it depends on their nature, or natural means of protection, than on the seasons. An oak tree sheds its acorns in autumn, and the leaves which fall afterward afford them some protection from frost and excessive dryness. But the leaves might be blown away from one spot, and the acorns exposed to intense frost or drought, either of which will speedily kill them. In another spot the leaves may drift into thick layers, with an excessive accumulation of moisture, causing decay of the underlying acorns; and there are many other unfavorable conditions which may destroy the vitality of the acorn. It is apparently impossible, however, to preserve an acorn's vitality by any artificial means for more than one season.

The scarlet runner bean loses its germinative power on exposure to comparatively slight frost, the degree depending upon the amount of moisture in it; yet it will retain its vitality for an almost indefinite period under favorable artificial conditions. In both of the examples given, germination would naturally follow as soon after maturation as the conditions allowed. The seeds of the hawthorn behave differently. Each haw contains normally three to five seeds, every one of which is incased in a hard, bony envelope, in addition to its proper coat or testa. Committed to the earth, and under the most favorable conditions, these seeds do not germinate till the second year, and often not so soon. In this instance prolongation of vitality is probably due in some measure to the protective nature of the shell inclosing the seed.

Returning to seeds in which the embryo or plantlet forms only a very small part of the whole body, wheat may be taken as a familiar and easily observed illustration of a seed, the vital energy of which requires very little to stimulate it into active growth; and yet this same seed, having no special protection in the way of coating, will retain its vitality as long, perhaps, as any kind of seed, if not under the influence of moisture. The primary condition to the preservation of vitality in a seed is perfect ripeness. Unripe seeds of many kinds will germinate and grow into independent plants if sown immediately after removal from the parent. The facility with which immature wheat will germinate is most disastrously exemplified in a wet harvest, when the seeds will sprout while the corn is standing or in sheaf; thus destroying more or less completely the value of the grain for flour, as the starch or flour is consumed in the development of the embryo, or what is left is so deteriorated by chemical change that it is not good for food. There is perhaps no other seed more susceptible to moisture, and none less affected by dryness or by heat or cold in the absence of moisture.

The kind of vivipary exhibited by the wheat is occasionally observed in various other plants; and sometimes the seeds of pulpy fruits germinate in the fruit. There is also a class of plants in which vivipary is normal. Prominent in this class are the mangroves (Rhizophoreæ, etc.) of muddy seashores in the tropics. In these plants there is a remarkable adaptation to conditions which insures their reproduction. From the very inception of the embryo there is no apparent interruption of active vitality in its development and germination. In the earliest stage the cotyledons or seed leaves are formed, and the radicle or future primary root is represented by a very small point. When the former have attained their full development, which is not great, the latter begins to grow and rapidly increases in size.

Each fruit or seed vessel, it should be mentioned, contains only one seed, the rootlet of which points to the apex of the fruit. Soon this rootlet pushes its way through the apex of the fruit and grows into a spindle-shaped body of great density and length; the cotyle-

dons or seed leaves remaining partly inside the fruit and acting as an organ of absorption from the parent plant to nourish the seedling.

In Rhizophora mucronata this radicle attains a length of two to three feet, and the seedling eventually falls, and by its own weight penetrates and sticks in the mud, leaving the fruit, containing the exhausted cotyledons, attached to the tree, where it dries up. Another singular adaptation to conditions is the vital development of the seeds of aquatic plants which ripen their seeds on or under water. Vallisneria is a remarkable instance of this. The unisexual flowers are formed under water; the female on long coiled stalks, which at the right period uncoil, and the flower rises just above the surface of the water. Simultaneously the short-stalked male flowers are detached from the base of the leaf stalks, and also rise to the surface. After impregnation has taken place, the stalk of the female flower coils up again and draws the seed vessel down under water, where the seeds ripen.

It has been explained that heat, moisture and air are necessary to the germination of seeds, varying immensely for different seeds. We come now to the behavior of certain seeds under the influence of an unusual or unnatural amount of moisture, heat or cold, especially in relation to the length of the duration of the exposure to any one of these factors. It has been proved beyond dispute, by actual experiment, that the vitality of certain seeds, notably various kinds of bean and convolvulus, is not impaired by immersion in seawater—or rather floating and partially submerged—for a period of at least one year; and that after having been kept quite dry for two or three years. Plants are actually growing at Kew from seeds treated as described; and some years ago several seeds of Entada, cast ashore in the Azores, whither they had been transported by the Gulf Stream, were raised at Kew. So far as at present known, all the seeds that will bear very long immersion without injury have an intensely hard, bony or crustaceous coat, that would withstand boiling for a minute or two without killing the embryo. Yet it is difficult to understand this power of resistance, especially after being kept dry for a long time. This imperviousness to water explains the wide distribution of many seaside plants, the seeds of which are conveyed by oceanic currents. How long such seeds would retain their vitality in water is uncertain, because experiments have not reached the limit. Many readers will remember Darwin's experiments in this connection; but it should be borne in mind that they were chiefly with seeds of plants not at all likely to be dispersed by the sea.

It has already been stated that some seeds will bear immersion in boiling water for a short time, and gardeners occasionally practice this treatment to accelerate the germination of hard coated seeds. But seeds of all kinds will bear for a considerably longer period a much higher dry temperature than soaking in water of the same temperature. It is recorded, by trustworthy authorities, that the seeds of many plants—poppy, parsley, sunflower, and various kinds of grain, for instance—if perfectly dry, do not lose their vitality when subjected to a temperature of 212° F. for forty-eight hours; and for shorter periods to a much greater heat. The result in most cases, though not all, is a considerable retardation of germination. Dry grain is equally impervious to cold. In 1877, seedling wheat was exhibited at the Linnean Society that had been raised at Kew from grain that had been exposed to the intense cold of the Arctic expedition of 1874 to 1876. The next question that arises is: how long do seeds retain their vitality when stored in the ordinary ways adopted by dealers? As a rule seedsmen and gardeners prefer new seed, because a larger percentage germinates: and mixing old seeds with new tells its own tale in irregular germination. Nevertheless, there are many seeds that retain their vitality from five to ten years sufficiently well to be depended upon to yield a good crop. Old balsam seed, other things being equal, has the reputation of yielding a larger proportion of double flowers than new; and some gardeners consider that cucumber seed of four or five years of age gives better results than the seed of the previous year. As already mentioned, perfectly ripened seed will retain its vitality longer than imperfectly ripened seed. In illustration of this, we note that carrot seed grown in France retains its germinative power, on the average, longer than English-grown seed, owing to climatal differences.

There is one other natural condition in relation to the vitality of seeds that should be mentioned; that is, the duration of the vitality of seeds on the mother plant. Some of the Australian Proteaceæ and some of the fir trees, especially North American, bear the seed vessels containing quick seeds of many successive seasons; and only under the influence of excessive drought or forest fires do they open and release the seed. Rapid forest fires are often not sufficient to consume the cones, but sufficient to cause them to open and free the seed for a succession of trees. The unopened cones of thirty years have been counted on some fir trees; and it is averred that the first seed vessels of some proteaceous trees do not open to shed their seed under ordinary conditions until the death of the parent plant, so that a tree may bear the accumulated seed of half a century or more.

Finally, a few words respecting the extreme longevity attributed to certain seeds. The reputed germination of "mummy wheat," from two to three thousand years old, has been the theme of much writing; but the results of careful subsequent experiments with grain taken from various tombs do not support the doubtless equally conscientious, though less skillfully conducted, experiments, supposed by some persons to have established the fact of wheat of so great an age having germinated. Indeed, it is now known that the experiments mainly relied upon to prove this long retention of vitality were falsified by the gardener who had charge of them. Nevertheless, there is no doubt that some seeds do retain their vitality for a very long period, as is proved by numerous well authenticated instances. Almost every writer on physiological botany cites a number of instances. Kidney beans taken from the herbarium of Tournefort are said to have germinated after having been thus preserved for at least one hundred years. Wheat and rye are also credited with having retained their vitality for as long a period. Seeds of the sensitive plant (Mimosa pudica) kept in an ordinary bag at the Jardin des Plantes, Paris, germinated freely when sixty years old. A long list might be made of seeds that have germinated after being stored for twenty-five to thirty years. If seeds retain their vitality for so long a period as this under such conditions, it is quite conceivable that seeds buried deep in the earth beyond atmospheric influences and where there was not excessive moisture, might retain their germinative power for an almost indefinite period; and the fact that plants previously unknown in a locality often spring up where excavations have been made bear out this assumption. The same thing happens in arable land, should the farmer plow deeper than usual; and deeper tillage, which would otherwise be beneficial, is often avoided on this account. A careful writer like Lindley states, though without qualification, that he had raspberry plants raised from seed taken from the stomach of a man whose skeleton was found thirty feet below the surface of the ground. Judging from coins found at the same place, the seeds were probably 1,600 or 1,700 years old. One more example of seeds germinating that are supposed to have been buried some 1,500 to 2,000 years. About twenty years ago, on the removal of a quantity of slack of the ancient silver mines of Greece, several plants sprang up in abundance previously unknown in the locality. Among these was a species of Glaucium, which was even described as new; and it is suggested that the seed may have lain dormant for the long period indicated. But there is not the amount of certainty about any of these assumed very old seeds to convince the skeptical or to establish a fact. It remains yet for somebody to institute and carry out careful investigations where excavations are being made.

W. BOTTING HEMSLEY.

NORTH AMERICAN WOODS.

MR. MORRIS K. JESUP, in 1880, conceived the idea of making a collection of North American woods for the American Museum of Natural History in Central Park, N. Y. It was about this time that Prof. Charles S. Sargent was engaged upon his great forestry report for the Tenth Census, and Mr. Jesup induced him to undertake the work for him in connection with his census duties. Mr. Jesup was at that time one of the trustees of the museum and is now its president. It was supposed at the start that the cost of forming the collection would be perhaps $10,000, but the task proved to be more difficult and expensive than any one supposed and the total outlay probably amounts to well nigh ten times that figure. This magnificent sum has been gladly contributed by Mr. Jesup, in the interest of science, and the work is not only of extraordinary scientific value, but of great practical account for the timber and wood working interests of America. For it enables persons who are in any way concerned in the subject to obtain direct knowledge as to the character of any kind of wood native to North America simply by a visit to the museum. The specimens consist of large sections, several feet long, cut from the trunks of typical trees of every species. They are several hundred in number, the drawings shown by Mrs. Sargent at the St. Botolph Club being but a comparatively small number of examples selected from the extensive work which she has now almost completed, and which has engaged her attention for the past fifteen years. Her portion of the task has been one of the most difficult as well as one of the most delicate. It has been necessary for her to have before her examples of the leafage, the blossoms and the fruits of every specimen. For much of the work she had to make long and difficult journeys with her husband, and for other examples fresh specimens have had to be sent to her home in Brookline for long distances and in a way that would preserve them in good condition. There would often be an interval of several months between the time of bloom and that of the maturing of the fruit, and the representation of a species could not be completed until the latter was before the artist. Sometimes it might be several years before a specimen of the fruit could be obtained and the work finished. Many of the specimens of wood could be obtained only with the greatest difficulty, and at corresponding expense. For certain trees are only found in places remote from lines of travel and transportation, or perhaps high up on the slopes of mountains, without even a trail leading to the spot. A fine example of one species that grows on the mountains of the coast range of California, for instance, was obtained by killing some cattle pastured in neighboring valleys and wrapping the log cut from the trunk securely in their hides, so as to prevent damage to the bark, the preservation of which intact was essential to the scientific value of the specimen. Protected in this fashion the log was then rolled down the mountain slope, and tumbled over a cliff into the sea, where it was towed by a boat, and with great difficulty got into a larger craft and brought to San Francisco for shipment East. A specimen of the giant tree of California, obtained by Prof. Sargent for the collection, is a section of the trunk 19 feet in diameter, the finest that has ever been secured. A section cut just above this one was secured by the British Museum.

In this collection many of the specimens have been properly seasoned only with the greatest trouble, and in some instances several years have been required for the operation. Seasoning has only been practicable in some cases by hollowing out through the center of the log and standing it over hot steam pipes. Much bother was experienced by the bark dropping off from certain specimens, and considerable ingenuity was required to secure it in place so as to present a thoroughly natural appearance. But, as the specimens are kept in glass cases, almost airtight, there is no trouble in keeping them in proper condition after they have once been treated, and there is no reason why they should not keep for ages. In order to show the character of the wood under various aspects a large piece is sawn from the upper end of each specimen in a way to make a vertical, a horizontal, and a sloping cut. One half of the surfaces thus exposed is polished, and the other half left plain. In this way one may behold not only the natural wood with the bark, but the grain under various aspects of cutting and finish. Affixed to each section is a forestry chart of North America, representing the distribution of species. The range of the species in question is specifically marked, together with the location from which the specimen was taken. Then each specimen is also accompanied by Mrs. Sargent's drawing in water color, representing the leafage, blossom and fruit. In this way a complete idea of the species may be obtained. The collection has just been removed from the old part of the museum to a great hall in the new wing designed with special reference to its exhibition. The arrangement is according to the botanical sequence of orders, genera and species adopted by Prof. Sargent in his monumental work, "The Sylva of North America." A duplicate collection of smaller specimens, formed of the pieces sawed from the ends of the examples at the New York Museum, was a feature of the forestry exhibit at the World's Fair at Chicago, and has generally been presented to the Arnold Arboretum here in Boston by Mr. Jesup. It will be installed in the museum of the institution, and will be of great value to students in connection with the work at the Arboretum. It is to be hoped that in some way means will be found for securing duplicates of Mrs. Sargent's unique drawings, as they are much needed to complete the collection here. It has been suggested that this might be done at a comparatively slight expense by a photo-mechanical color process. An edition of plates reproduced in this manner would be of high scientific value, and would be in demand by botanical students and scientific institutions throughout the world.—Architect, Builder and Decorator.

RECENT GLACIAL STUDIES IN GREENLAND.*

DURING the summer of 1894 Mr. Chamberlin was enabled to devote some time to a personal study of the glaciation of Greenland, and the results of his observations are so interesting that all geologists who seek to interpret the records of the "Great Ice Age" will gladly make acquaintance with them. Seldom has a geologist so experienced in the study of glacial drifts and of the problems connected with them had the advantage of examining the behavior of ice in the Arctic regions.

His observations were specially directed to the way in which a glacier gathers up detritus along its course, to the way in which it carries it forward and finally puts it down. The main problem he sought to solve was connected with the basal material of glaciers, debris which, of course, is largely concealed.

In comparaing the glaciation of Greenland with that of the mainland of North America, he had to bear in mind that for the most part the continental drift is spread over a vast plain. In Greenland the ice fields rest mainly on plateaus fringed by rugged mountains, and he sought for a tract free from such bordering elevations. This was found at Inglefield Gulf, where the borderland is a plateau about 2,000 feet above sea level, and where the margin of the great ice sheet may be studied on relatively smooth ground, on undulating ground and in lobes or tongues that descend the valleys. Of the thirty or forty glacial tongues which descend toward Inglefield Gulf less than one-third reach the shore, and scarcely one-half of these discharge notable icebergs. The majority terminate in valleys whose bottoms are formed of glacial debris and whose lower gradients are moderate.

The fact that great part of Greenland appears to consist of ancient gneissic rocks renders the debris more or less stony and arenaceous; clayey material is rare. About Inglefield Gulf, however, the older rocks are covered by thick layers of sandstone and shale, traversed by basic igneous dikes. Hence it is possible there to tell how late the erratics from this sedimentary series were introduced into the ice, to ascertain what courses they pursued and the actions they suffered.

The margins of the Inglefield glaciers rise abruptly like escarpments of rock, 100 or 150 feet or more. The layers of ice are cut sharply across, exposing their edges, and the formation of these scarps is attributed to the lower inclination of the sun's rays, which strike vertically and effectively against the edges of the glacier, whereas its back is affected only by rays of low slant.

The stratification of the glaciers attracted particular attention. The ice was found to be almost as distinctly bedded and laminated as a sedimentary rock. The vertical face was seen usually to present two great divisions, an upper tract of thick, obscurely laminated layers of nearly white ice and a lower laminated tract discolored by debris. At the base there is usually a talus slope and sometimes there is a moraine. In the lower portion of the ice there are here and there interstratified layers of sand and silt, rubble and bowlders. These vary from a mere film of silt to a heterogeneous mixture of debris and ice several feet thick. The detritus is usually arranged in definite and limited horizons, the ice above and below being firm, clean and pure. Often a fragment of rock or a bowlder of considerable dimensions will be several times thicker than the silt layer, and it projects above and below into the clean ice. The debris layers, though often regular and persistent, frequently thin out and disappear. Lenses of debris also appear, and the layers are sometimes doubled back upon themselves.

The laminæ of the ice are sometimes very symmetric, straight and parallel, but often wavy and undulating. In many instances they are greatly curved or contorted. Thus, as Dr. E. von Drygalski has remarked, they closely simulate the foliation and contortion of gneiss.

The debris belts, which are essentially parallel to the base of the glacier, are confined chiefly to the lower 50 or 75 feet, but they occur up to 100 feet and perhaps to 150 feet. They are more abundant at the sides of the lobes than in the center; a notable portion of the debris having evidently been introduced after the lobes were formed. Thus the detritus appears most abundant in glacier lobes which descend as cataracts or crowd between closely hugging cliffs.

In meeting obstacles the basal beds of the glacier sometimes simply curve upward, carrying their debris with them over the obstacle; at other times the laminæ of ice are much crumpled. Not only are the foliations of the ice twisted, but they are at times fractured and faulted, and along the fault plane the laminæ are affected by "drag," as in faulted rocks.

The general stratification of the ice had its initial stages in the original snow falls; and the seasons

* Abridged from a paper by T. C. Chamberlin in the Bulletin of the Geological Society of America, February, 1895.—Nature.

doubtless developed annual subdivisions. The more definite partings and the introduction of the layers of debris arose through a shearing movement between the layers of ice.

The actual process of intrusion of detritus was observed in proximity to a large boss of rock which, protruding through the margin of the ice, had been partially cut away. Trains of debris, apparently rubbed from the surface of the rocky dome, were carried out almost horizontally into the ice in its lee. Some of these were short, while others extended several rods into the ice, passing into the body of it instead of following its base. At one point the overthrust of the ice reached such a degree as to carry the earthy layers obliquely across the thickness of the glacier, producing a marked unconformity.

In another instance similar features were observed below an ice cataract. Tongues of debris, having their origin in the bowlder clay below the glacier, were seen to reach out into the basal portion of the ice as though they were being introduced into it by the differential movement of the layers upon each other. Thus when the ice is forced over a prominence it settles down a little in its lee, and is then protected somewhat from the thrust of the ice behind. The next ice that passes over, being prevented by the former portion from settling down at once, is thrust forward over it. This is accomplished by the bending and doubling of the layers, and also by distinct shearing. At length, however, the first layer is compelled by the general friction to move somewhat forward, and in time to join the common moving mass, carrying the overthrust layer of debris between it and the ice layer above.

It appears obvious that the ice in the lee of a rocky prominence moves more slowly than that above; hence the doubling of the laminæ upon themselves. Moreover, there is a gradation from laminæ that simply suffered doubling up to layers that obviously sheared upon each other and produced manifest unconformity by overthrust.

Evidence showed that the more solid (blue) bands in the ice are produced by exceptional pressure in moving over rugosities, and that their position in the ice is parallel to the ice movement; while at the same time blue bands may be developed nearly at right angles, after the manner of slaty cleavage.

Summarizing the above conclusions, it appears that stratification originated in the inequalities of deposition, emphasized by intercurrent winds, rains, and surface meltings; that the incipient stratification may have been intensified by the ordinary processes of consolidation; that the shearing of the strata upon each other still further emphasized the stratification, and developed new horizons under favorable conditions; that basal inequalities introduced new planes of stratification, accompanied by earthy debris, and that this process extended itself so far as even to form very minute laminæ.

There is involved in the foregoing conceptions the idea of an ice layer acting as a unit of movement; at any rate, there is recognized individuality of movement in the layer. This view involves the idea of rigidity rather than viscosity. The introduction of earthy material into the ice layers involves the idea of thrust rather than pull. The picture is not that of gravitation pulling a thick, stiff liquid down the lee side of a rocky prominence, but of a rigid body thrusting itself over the crest by means of a force in the rear.

The extreme fragility of the ice is difficult to harmonize with the idea of viscosity. Wherever the ice passed over an undulation of even moderate dimensions, it was abundantly crevassed. There was no indication that bowlders descend through the ice as heavy substances descend through viscous bodies. The rigidity did not prevent contortions and foldings of the laminations, such as take place in crystalline rocks, but faulting and vein structures also occur, and there seems no more occasion to assume viscosity in the one case than in the other. Even if a certain measure of viscosity be admitted, it does not follow that viscosity was an essential agency of motion. The crystalline body may readily be made to change its form by the removal of particles from one portion by melting, and their attachment at other points by congelation; but not, apparently, by the flowing of crystallized particles over each other in their crystalline condition.

It has been already pointed out that much basal material is carried in the lower layers of ice. It was also a matter of frequent observation that debris lies under the ice. Apparently the ice sometimes pushes this along, and sometimes slides over it. At the end of the glacier the debris within the ice is freed by melting, and accumulates as a talus slope This sometimes protects the basal layers from melting, and they become at length incorporated in the growing accumulation.

It appeared, from the stages presented by the several glaciers, that where the ice is slowly advancing, the talus slope gradually grows forward and constitutes an embankment, upon which the glacier advances. It thereby grades up its own pathway in advance. On seeing this process, one is at no loss to understand how ice can advance over fields of sand or soil without in any way disrupting them. It buries them before it advances upon them.

Where the frontal material accumulates in a large mass, it opposes such a degree of resistance to the ice that its layers are curved upward on the inner slope; and if the glacier subsequently advances, the ice rides up over the moraine. Several such instances were observed, but none was seen where the ice showed any competency to push even its own debris, in notable quantity, in front of it. The ice is weaker than the moraine as a whole.

Great quantities of snow are carried by winds from the region of the great ice cap, and this snow may be lodged in immense heaps in the lee of the terminal moraines. Such a border drift may have a breadth of from 1,000 to 3,000 feet. It becomes solidified after the fashion of a glacier, and may serve to arrest or deflect the main ice, for it was observed that the basal layers of the ice in places curved upward on encountering the resistance of this wind-drifted accumulation.

The rate of movement of the majority of the glaciers was found to be exceedingly slow, though a few which produce large icebergs are notable exceptions.

The amount of drift on the territory once occupied, but now free from ice, was scanty. At some points there are considerable accumulations of drift within a mile or two of the present ice front, but over much of the area no great moraines, nor any thick mantles of drift, were to be seen. There was but moderate evidence of glacial action; the land was gently rounded, but not greatly moulded. In this area of Southern Greenland tracts of angular, unsubdued topography alternate with rounded, flowing contours. The inference was drawn that the ice formerly so extended itself as to reach the present coast for about half its extent, while in the remaining portion the ice fell short. Thus the conclusion seems unavoidable that the ice of Greenland, on its western side, at least, has never advanced very greatly beyond its present border in recent geologic times. This carries with it the dismissal of the hypothesis that the glaciation of the mainland of North America had its source in Greenland.

There is no ground to question the former elevation of Greenland, but it would appear that this was not coincident with conditions favoring glaciation.

H. B. W.

THE ENGLISH SPARROWS.

THE English sparrow, which is more properly called the house sparrow, was first brought to this country in 1850, when the directors of the Brooklyn Institute imported sparrows into Brooklyn, N. Y. This first colony did not thrive, and in 1852 a second was imported. In the spring of 1853 the birds were let loose in the grounds of Greenwood Cemetery. They did well, and from this original stock are derived quite a number of sparrow colonies in other parts of the United States. In 1854 and 1858 sparrows were imported to Portland, Me.; in 1860 twelve birds were introduced into Madison Square, New York; in 1864 others were placed in Central Park, and in 1866 two hundred were let loose in Union Park. Between 1867 and 1881 the sparrow was imported from Europe directly to New Haven, Conn., Galveston, Tex., Charlestown, Mass., Cleveland, O., Philadelphia, Pa., Salt Lake City, Utah, Akron, O., Fort Howard, Wis., Sheboygan, Wis., and Iowa City, Ia. From these colonies the little brown bird has spread far and wide. Like the bee, it goes only where man has preceded it, and it loves the habitations of men more than the most fruitful wilderness. It was brought to this country for the express purpose of keeping down insect pests which are now almost forgotten. In the sixties it was impossible to pass under the trees in the city of New York without being annoyed by the disagreeable caterpillar, called the measuring worm, which infested every green thing, and which was constantly falling upon the passenger below. This and other insect pests have altogether disappeared wherever the sparrow has been introduced, and if the sparrow were to be removed—though that is perfectly impossible—no doubt the same disagreeable insects would reappear.

At the present time, the house sparrow has been established and acclimated all along the Atlantic coast, from Maine to Wisconsin on the north, and from Utah on the west to Georgia on the south, not counting large settlements which have been made in Louisiana, Salt Lake City, San Francisco and at various minor points of the South and West. For a considerable time the sparrow was welcomed for his usefulness, and in twenty-three States of the Union he was protected by general or special laws; but it is possible to have too much of a good thing, and in certain parts of the country people are thinking that they have too much of the English sparrow. Hence, several States have excepted the sparrow from the protection which the law affords to other birds, and, more recently, several States have gone so far as to offer bounties for their destruction. Unfortunately, as we consider, the official ornithologists of the United States Department of Agriculture have set their faces against the sparrow, and we are constrained to say that they seem to us to have been controlled to a large extent by prejudice. That their investigations have been made with great diligence is evident; but in some cases, certainly, they seem to have allowed their prejudice rather than the facts to control their judgment. For example, in treating of the alleged injury done by the sparrows to buds, blossoms and foliage, the department had reports from 584 observers. Of these, 265 alleged "positive damage of varying kind and degree," while 307 were "favorable to the sparrow," and 12 were "indeterminate." The inference of the department seems to be that this showing is exceedingly damaging to the sparrow; but one would like to know the "kind and degree" of damage which is reported by the 265; and we cannot admit that the 307 favorable reports, which say that the writers had observed no such damage from the sparrow, are to be considered as furnishing merely negative evidence. They seem to us to be reports of the most positive kind—for what more positive report could be given by any observer than that he had observed no injury from the sparrow to buds, blossoms or foliage? No doubt the intention of the ornithologists is entirely good, but the whole report, which we have before us, seems to be tinged with an unscientific one-sidedness which deprives it of the confidence that one would like to repose in a report from a department of the United States government.

The great difficulty—and it is undoubtedly a great difficulty—is that the sparrow is one of the most prolific of living creatures. It rears from twenty to thirty young in the course of a year. If the average were twenty-four, and if all the sparrows which are produced were to survive, the report of the Agricultural Department shows that, at the end of ten years, the total number of birds from that single pair and its progeny would be 275,716,983,698! Of course, the actual increase of the sparrow is only a fraction of this amount, for its fecundity is counteracted in many ways. The sparrow has its natural enemies, such as cats, hawks, jays, and the like; it is subject to disease; it is always dependent upon the supply of food; it is exceedingly sensitive to thunder storms, thousands sometimes perishing, especially when the storm is accompanied by high wind; and although the sparrow can endure any extreme of temperature that is known in the United States, it starves in large numbers when its supply of food is covered with the snows of winter.

Making every allowance, however, it may be admitted that in some places there are too many sparrows. In cities, for example, it has been found necessary to protect the eaves and cornices of houses from their nests and the trees are sometimes reduced to an unsightly condition by the multitude of sparrows which nest in their branches. The simple remedy in this case is to keep the streets of the city clean; for, if the streets are clean, the sparrow must either perish for want of food, or betake himself to some place where the supply of food is greater; and so long as the streets are not kept clean, the sparrow is one of the useful of scavengers, diligently collecting and consuming substances which would otherwise decay and taint the atmosphere.

It is alleged that the sparrow does much damage to the buds, blossoms, and leaves of various trees and plants. There seems to be some truth in the allegation; but in the voluminous evidence which has been collected by the Department of Agriculture, we find no single instance in which any tree of any kind has been destroyed by the sparrow, as would surely be the case if their depredations were seriously injurious. In the case of fruit trees it is simply incredible that the sparrow should destroy any such amount of blossoms as to affect the crop. There is hardly a fruit tree which does not produce innumerable blossoms that can never be developed. In a city, of course, where fruit trees are few and sparrows are numerous, it is possible for some damage to be done; but in an orchard, where the blossoms must always outnumber the birds many thousand-fold, we think the damage must be inconsiderable.

The injury which the sparrow is said to do to trees in which it nests, by the filth which it deposits there, is likewise confined to cities. We admit it to be possible that when hundreds or even thousands of these little birds nest and roost together in one tree, the beauty of the foliage must be marred; but if the fear of the Agricultural Department, that in such a case the life of the tree is endangered, were well founded, one might surely expect such diligent investigators to be able to report at least one case in which the catastrophe has occurred. We find no such case in the report. Here again, as before, the remedy, where the evil exists, is simply to keep the streets clean. Where that is done, there will be no such number of sparrows to defile the trees. Where it is not done, a candid investigator, in thinking of the filth which they deposit in one place, ought to make allowance for the filth which they remove from other places; and in considering the possible and occasional injury, he ought to bear in mind the millions of filthy measuring worms which the sparrows have removed, and which were much more dangerous than the sparrow to the life of the trees which they infested.

Again it is said that the sparrows are destructive to the seed sown by the farmer; but what of the millions of seeds of weeds that the sparrow consumes? Is it not possible, perhaps, that the little brown bird may save the farmer far more in preventing the growth of weeds than he wastes by the consumption of a few seeds in spring time? And then what of the insects that he consumes when the crops are growing, and when he has nothing but insects and the seeds of weeds to live upon? We fully admit that the sparrow may increase to such numbers as to become a nuisance; but, taking him all in all, we are inclined to think that he is a very useful servant, and that he gives far more in service than he takes in his occasional maraudings.

Perhaps the strongest argument against the sparrow is that he drives away the song birds. In certain cases that is possibly true. When the coming of song birds is encouraged by the building of boxes for them to nest in, the sparrow is quite prone to oust the song birds and to take possession of the boxes. If he finds a tree to be particularly convenient, he takes possession of that; and so it is unfortunately true that some of our native songsters are rarer than they used to be. Unfortunately, however, the sparrow is the least of the enemies of our song birds. The bobolink has become rare in New England, but it is the mowing machine and the early cutting of hay, not the sparrow, that has driven him away; and elsewhere it is to the small boy and the purveyor of the restaurant, who go out to kill anything and everything that has wings, that we owe the disappearance of our song birds much more than to the sparrow. In Europe song birds and sparrows thrive together; and for one song bird that is native to the United States there are at least ten or twenty that are abundant in Europe. In the United States we have few song birds and they ought to be protected against all enemies, even the sparrow; but in Europe the larks and finches and nightingales find no difficulty living in the neighborhood of the sparrow; and in this country, if we could take away the gun from the small boy and put the purveyor of the restaurant in jail, it is probable that our song birds would flourish quite well in spite of the sparrow.

For one thing the friends of the sparrow are greatly indebted to the ornithologists of the Department of Agriculture, who have proved to demonstration the absolute futility at this date of attempting to extirpate the sparrow where he has been naturalized. The State of Illinois offered a bounty for the destruction of sparrows which could not possibly have any appreciable effect on the number of birds and which could have no other effect than that of training boys to the destruction of bird life. The ornithologists of the department have shown that if the total number of sparrows in the State of Illinois were assumed to be 40,000,000, which is an exceedingly moderate computation, and if the most vigorous and systematic efforts were to be made for their extirpation by an offer of bounties which must be increased year by year as the killing of the sparrows became more difficult, the natural increase would require a total of at least 120,516,849 birds to be killed at a cost of from two millions and a quarter to eleven millions of dollars; and still, at the end of five years, there would remain a quarter of a million of birds, which would be sufficient in another five years to repopulate the State with sparrows almost as densely as at present. This is clearly a reductio ad absurdum. The sparrow cannot and will not be extirpated. All attempts to destroy it where it is established as it is in the State of New York and the State of Illinois will be simply futile. Their only effect would be to train small boys and vagabonds to live a lazy life by the destruction of sparrows.

What, then, is the remedy when sparrows become so

numerous as to be a nuisance? When that fact really occurs, no mere sentimentalism ought to prevent the destruction of an animal which has become a pest. The ornithologists of the Agricultural Department tell very plainly how they can be destroyed; but far better than any such methods of destruction would be the introduction and protection of other birds which are the sparrows' natural enemies. "Probably the most useful bird in this respect is the northern shrike, which visits most of our northern cities in winter and feeds freely on the sparrows. At one time this shrike became so abundant on the Common and public gardens in Boston that it threatened to destroy all the sparrows." The bluejay is another enemy of the sparrow in many cities and towns of the Mississippi Valley. The crow-blackbird or purple grackle at one time increased rapidly at Cambridge, and at that time, very naturally, the sparrows did not increase at all. The sparrow-hawk and the screech owl might be encouraged in the parks of cities, and they would remain there just as long as the sparrows might continue to be abundant. There is no effective way to fight nature but with nature's weapons. The sparrow fought the caterpillar successfully, and in his new habitat where he finds an abundance of food he has increased perhaps beyond measure. Then let nature keep the sparrow down, as nature keeps him down elsewhere; but to turn the boys of a great State or a great city loose at sparrow killing would be to demoralize the boys and turn many a hopeful lad into a life-long loafer.—Our Animal Friends.

THE SWALLOW-TAILED KITE.

(ELANOIDES FORFICATUS)

WE have taken the liberty of quoting portions of the life history of this species as written by Captain Charles E. Bendire, Curator of the Oological Department of the National Museum at Washington, D. C., in his work entitled "Life Histories of North American Birds."

"Tropical and warm temperate portions of North America; north in the interior regularly to Illinois, Iowa, Minnesota, casually to Manitoba, and Assiniboia, etc.; along the Atlantic coast casually to Pennsylvania, New York, and southern New England; accidental in England.

"Although the breeding range of the swallow-tailed kite within the limits of the United States must be considered to be quite extensive, it is a very irregular one, and the birds are only summer residents over the greater part of their range. It breeds regularly in Florida and South Carolina, and probably farther north along the Atlantic seaboard, in the States of North Carolina and Virginia, and apparently even in New York State, where several kites were observed on different occasions in Rensselaer County, in the latter part of July and the beginning of August, 1886, strongly suggesting their breeding in that vicinity during the season in question.

"From Florida westward it is irregularly distributed through the Gulf States, including the greater portion of Texas. It also breeds in the interior in suitable localities throughout the entire length of the Mississippi Valley, and in the States adjacent to our northern boundary, and a few pass this, as it has been observed on different occasions in the British provinces of Assiniboia and Manitoba, in lat. 50°.

"Stragglers have been taken during the summer months in many of our Northern States as well as in England, but few winter within our borders, and, excepting in portions of Florida and Texas, it must be considered as rather a rare species throughout its summer range. It is also found throughout a greater part of the South American Continent as far south as the Argentine Republic and Chile.

"Dr. William L. Ralph, who has had excellent opportunities to observe the swallow-tailed kite in Florida during several seasons, writes me as follows about it: 'Excepting, perhaps, the turkey vulture, I think this bird is the most graceful of any while on the wing. It has the same easy floating motion, but at times it flies very rapidly and turns very quickly, which is something I have never seen the former bird do. Their motions are very swallow-like; and that, with their forked tails, makes them look like gigantic barn swallows; and like the chimney swifts when they have a habit of traveling together in small companies, usually consisting of three individuals, especially when they first return from the South. During the breeding season flocks consisting of from two to three to ten or twelve birds, but oftener of three, may be seen following one another around, frequently uttering their calls and circling in and out among the tree tops so fast as to make one dizzy to look at them. Except during this season one seldom sees one of these birds unless it is flying, and I have often wondered if they did not at times sleep while on the wing. At least I know that they usually, if not always, eat while flying, for I have many times seen one sailing leisurely along, occasionally bending its head to tear a piece from a small snake that it held in its talons, and I have never seen one alight to eat its food, as other birds of prey do.'

"When hunting they fly quite close to the ground, like marsh hawks, but at other times they sail above the tree tops, sometimes so far above that it takes a good eye to see them. Their food consists almost entirely of reptiles. Small snakes seem to be a favorite article of food with them. I never have seen one catch a bird, and believe they do not. This habit of catching snakes has given them the name of 'snake hawk' among the natives of Florida.

"Swallow-tailed kites begin to arrive in this State from the South about the middle of March, but do not become common until two or three weeks later. They appear to be as abundant now as formerly, probably because most of the tourists have left Florida before they arrive in any numbers. Although these birds are common in the southern half of St. Johns County, and that part of Putnam County east of the St. Johns River, and though I have found quite a number of their nests, I have never been able to get but two sets of their eggs, owing to a habit they have of building in places that are very hard to reach.

"The first nest was taken April 22, 1887, eleven miles northeast of Palatka, Florida, and contained two eggs, so nearly hatched that the embryos in them were feathered. It was situated 90 feet above the ground in, or rather on, the top of a very slender pine tree growing on the edge of a cypress swamp. The trunk of this tree, at a height of five feet above the ground, was not more than fifteen inches in diameter, and at the place where my climber stood, as he took the egg, it was less than three inches, while the limbs he stood on were only an inch thick. The nest was composed of large twigs thickly covered with Spanish moss (Tillandsia usneoides) and long moss (Usnea barbata), lined with the same materials, with the addition of a few feathers from the birds. It measured twenty inches in length, fifteen in width, and twelve inches in depth on the outside, and six inches in diameter by four inches deep on the inside.

"The nests of this species are usually so very irregular that I should think they simply hollowed out bunches of mossy twigs that they found lodged in the tops of trees, had I not often seen them carrying this material to nests that they were building.

"Both birds were present when the eggs were taken and made much ado. They would dive at the head of my climber, uttering their shrill but rather feeble cry, and at times were so fierce that he had to stop and strike at them with his hat to prevent them from striking him. This set of egg is the earliest I have record of, and if it takes these birds four weeks to hatch their eggs, as it usually does the larger hawks in the north, they must have been laid before April 1. They usually commence laying about the middle of April, and I have found them sitting on their nests from that time until the 1st of June, being the latest date I ever remained in Florida. Most of them have their eggs laid by the middle of May. One nest which I saw these birds building was deserted for three or four weeks and then reoccupied, but whether or not by the original pair, I do not know.

"The second nest was taken seven miles northeast of San Mateo, Florida, April 14, 1888, and contained two fresh eggs. It was also situated in the extreme top of a slender pine, in every respect an exact counterpart of the one that held the first nest. The difference in the height of the two was less than a foot. As nearly as I could judge, about three-fourths of the nests of this species found by me were about the same distance above ground, i. e., they were ninety feet, and the remainder from a little above that height to 125 or 130 feet.

"The birds to which the second set belonged were not so pugnacious as the owners of the first, but they made a great fuss, and soon had four others of the same species with them to see what was going on, and these seemed as much concerned at the disturbance of the nest as the owners themselves. They were less fierce than the first on account of their eggs being fresher, for, like all birds, they exhibit more anxiety just before and just after the eggs are hatched than at any other time. The nest of this pair was composed of large twigs, Spanish moss and pine needles, lined with green moss and small twigs.

"The earliest date on which I found this species breeding was April 5, 1891, when I took a set of two eggs, eight miles southeast of San Mateo, Florida. Both eggs were rather smaller than the usual size and also lighter colored. One had been incubated for about a week, the other was fresh. The nest was situated in the extreme top of a slender pine, eighty-six feet from the ground. Both parents made much ado, flying down at my climber from above at an angle of about forty-five degrees. The call note of this species sometimes sounds very much like the peet, peet, of the spotted sandpiper.

"I think both parents assist in incubation, and that but one brood is raised in a year. In Florida, like the bald eagles, they nearly always nest in pine trees and in the tallest they can find, but, unlike the latter, which always select trees of the greatest diameter, they choose the very slimmest.

"They usually breed in wild, uninhabited localities, but, except in regard to their nests, they appear to have but little fear of man, and are often to be seen flying around among the houses of the small villages in this vicinity. The places resorted to for breeding are the low-lying pine woods, and the nests are usually built in trees that grow in or near the cypress swamps, so common in these situations.

"The swallow-tailed kite has a peculiar way of leaving its nest, for instead of flying directly from one side, as other birds do, it nearly always rises straight up for a short distance first, as if it were pushed up with a spring, and, when about to alight on its nest, it will poise itself a short distance above its eggs and then gradually lower itself down onto them. When they are thus poised above their nests there is scarcely a perceptible movement of their wings, and they often lower themselves so gradually that one can hardly tell when they have reached their eggs.

"The swallow-tailed kite is, on the whole, a perfectly harmless and beneficial bird, feeding to great extent on reptiles of various kinds, beetles, grasshoppers, crickets, cotton worms, small frogs, and tree toads. It is doubtful if it ever kills a bird.

"In Texas, the Indian Territory, and Kansas, this species builds frequently in the tops of the tallest cottonwood trees, occasionally in pine oaks or pecans where these are found, and always as near to the tops of trees as the nest can safely be placed.

"Nidification varies according to locality, beginning about the first week in April in the more southern portions of its breeding range, and correspondingly later farther north, sometimes not before the first or second week in June.

"Two eggs are generally laid to a set, occasionally but one, and rarely three or four. The average measurement of twenty specimens from different parts of the United States is 47 by 37 millimeters. The largest egg in this series measures 50 by 39, the smallest 41·9 by 34·5 millimeters. I consider these eggs as handsome as any of those of our raptores. They are usually oval in shape; some approach an elliptical ovate. The shell is moderately smooth and close grained. The ground color varies from a dull to an ashy white, and again it may be a delicate cream color.

"The eggs are spotted and blotched with different shades of rich brown and ferruginous, usually irregular in outline, and varying considerably in amount. These markings sometimes form an irregular band running from the center to the smaller end, and frequently become confluent. Occasionally a specimen is found in which the markings are very few and small in size, scarcely any being larger than a No. 10 shot, and the majority smaller. In a few specimens light lavender colored shell markings, generally of small size, are also visible. There is a great deal of difference in the style and markings of these eggs if a number are compared, but they can readily be distinguished from the eggs of any of our raptores."

DIRECTIONS FOR COLLECTING AND PRESERVING FISH.

By TARLETON H. BEAN.

1. WASH the fish thoroughly in water to remove the slime and dirt that are almost invariably present upon them, not omitting the inside of the mouth and the gills. In cleansing fish that have a tough, scaleless skin, or such as have the scales firmly fixed, use a stiff paint brush or a scrubbing brush; for the thin skinned fish and such as have deciduous scales, a softer brush must be taken. Some fish are covered plentifully with tenacious mucus that is with great difficulty removed by water alone. In such cases a solution of two tablespoonfuls of alum in a pint of lukewarm water will be found efficacious.

2. It is often necessary to preserve fish that are stale, or partially digested and offensive to the smell. Such examples may be thoroughly disinfected by the use of the disinfecting solution of chloride of soda.

Use a tablespoonful of the solution in one pint of water. With this wash the gills, and pour it into the mouth and stomach, allowing it to return by the mouth.

3. Inject alcohol in the mouth and the vent to preserve the viscera. Make small incisions in the belly and in the thick parts of the body, to allow the alcohol to penetrate the tissues. It is often necessary to remove the liver, stomach and intestines from large fish, and to preserve these separately, numbering them so as to correspond with the fish from which they are taken.

4. It is a good plan to keep freshly collected fishes in weak alcohol for a day or two; a mixture of two parts of 95 per cent. alcohol to one of water will answer for this temporary immersion. Some species are exceedingly soft and flabby, falling to the bottom of a glass jar or other receptacle, becoming partly embedded in their own mucus, and rapidly disintegrating in consequence. Such specimens should either be suspended in the alcohol by a thread or string from the neck of the jar or the hook sometimes found on the inside of the stopple, or a bed of excelsior or muslin should raise them from the bottom; these are necessary precautions which will prevent many losses.

After the fish have been kept for not more than two days in the weak alcohol, transfer them to a mixture of three parts of 95 per cent. alcohol to one of water. Ordinarily this latter will preserve specimens that are not crowded too much at least three months. Some, of course, will remain in good condition still longer, but generally three months will reduce the preservative power of the liquid so far as to make a renewal of alcohol necessary. The tendency with many collectors is to overcrowd specimens, and, as a result, museums frequently receive a lot of half rotten material which is too valuable to be thrown away, and is yet always a source of trouble and disappointment. A jar, tank or case of any kind should never be expected to accommodate more than half its own bulk of fish, and even this proportion will require watchfulness to avoid loss. If a collection freshly caught is to be shipped to a distant museum or private collection, observe the directions about cleaning the fish and preserving the viscera separately if needful, and then use nothing weaker than a mixture containing three parts of 95 per cent. alcohol and one part of water. A good mixture which will carry fish in very nice condition is the following: 95 per cent. (or absolute) alcohol, 3 quarts; water, 1 quart; glycerine, 1 pint; borax, 1 ounce. There is nothing better, however, than the mixture of three parts of alcohol and one of water.

5. The extensive collections of the United States Fish Commission are usually packed in copper tanks, which are tin lined within. The lid of the tank is made to screw in the top and its diameter is always as great as the dimensions of the top will allow. The tanks (called Agassiz tanks) are made to contain 4, 8 or 16 gallons. Strong chests, of a size large enough to accommodate a 16 gallon tank, are used for shipping; the hinges and hasps of these chests are riveted on. Handles are screwed on at the sides and each chest is furnished with a strong lock. The chest may contain one 16 gallon tank or two of 8 gallons or four of 4 gallons, or one of 8 gallons and two of 4 gallons, as may best suit the convenience of the collector. When several tanks make up the complement it is usual to separate them by thin wooden partitions.

Cases made of ordinary tinned sheet iron are much more generally used than the expensive copper cans, and they will answer well enough if the joints are perfectly tight and the top is securely soldered on.

Oak kegs, holding about 10 gallons each and provided with iron hoops, are capital containers for large fishes, and they will stand the wear and tear of railway travel better than most other receptacles.

Glass preserving jars may be shipped long distances with comparative safety, but they must be tested by inverting them to insure tightness. The top of the jar and the rubber band should be wiped dry. Wrap the jars in strong paper and pack them in some material that will prevent breakage.

When corked bottles are used, tie a piece of bladder securely over the cork. Where seals and sea lions occur, the throat, as prepared by the Aleuts for example, will be found an excellent covering. It is necessary to wet the membrane to make it pliable. Whenever jars, bottles or any other small containers are filled with fish which are not provided with tin tags, write plainly with a lead pencil on heavy manila or writing paper the name of the place where the fish were taken, the date of capture and the name of the collector. Put a label of this kind inside of each bottle; it will remain legible for years.

6. Each specimen should be provided with a numbered tin tag, which is to be fastened, whenever possible, by means of a string passed through the right gill opening and out at the mouth. When the string must be tied around the body or tail of the fish, it

should be fixed securely and yet without injuring any of the fins. A catalogue is to be kept by the collector, in which the numbers corresponding with those on the tags must be entered, with notes as to place, time and mode of capture, and other particulars which will be more fully mentioned further on. Wrap each fish separately in common coarse muslin (the coarser the better), and tie the ends securely. Do not tie the string so tightly around the body of the fish as to make furrows and wrinkles in the skin. If tin tags are not at hand, a label written firmly on stout paper with a lead pencil should be wrapped inside of the covering of the fish. It is necessary always to fill the receptacle in which specimens are packed—a bottle or jar may be either filled with alcohol or the specimens may be wrapped in muslin. It is not a good plan to put tow, excelsior or cotton wool on top of fish, as it presses them close together and prevents the free circulation of alcohol between them. For long journeys it is desirable to secure better protection than the muslin wrapping alone affords. This may be gained by placing beds of excelsior or thin wood shavings between the layers of fish and at the bottom and top of the case.

A plainly written card placed at the top of the box, so as to be seen when the lid is removed, telling its contents and by whom it was sent, will save much trouble when the collection is to be unpacked.

7. Notes of color, taken from the fresh specimens, should be sent with them if the fish are to be described in the museum. The collector should also preserve in his own books a record of life colors under the catalogue numbers corresponding with the tin tags fastened on his fish. He can then obtain the identification of his species by their numbers and publish his studies upon them at his own pleasure.

8. Local names of fish should always accompany the specimens when obtainable.

9. It is desirable to know whether or not the species is abundant; whether different sizes of the same fish are found; whether they associate in schools or not; whether they are permanent residents or migratory; if migratory, by what routes they come and go; whether they form an important article of food; what they feed upon and what species prey upon them; the depth and character of the bottom on which they occur; the mode of capturing them; the uses made of them and the various products which they go to form, in short, everything bearing upon the life history or the economic applications of the species should be noted in detail.

10. Before wasing the fish, look them over for external parasites; examine the gills and the inside of the mouth carefully, as these are favorite situations. These parasites often furnish a clew to the migrations of the fish; remove them if they can be taken off entire, if not, let them remain, and call attention to their presence in your shipping notes. Preserve the parasites in vials or bottles, and provide them with labels stating from what fish they came and in what situation they were found.

To preserve fish indefinitely in glass jars, observe the following directions: First, select a jar of the proper size to accommodate the specimen amply, without bending or distorting it in any way; put in the fish with the tail down in nearly all cases; the tail may often rest upon the bottom of the jar, or the fish may be suspended from the hook which is now found in the stopple of the modern museum jars; cover the fish completely with the alcohol mixture referred to in the closing sentence of paragraph 4; discoloration of the alcohol is a sign that its preservative power is weakened and calls for a renewal; fishes in alcohol will never make a good show unless the liquid is kept clear and clean. A label giving the name of the fish, place of its capture, and of its captor, should be tied on the neck of the jar by means of a piece of narrow tape passed through holes punched in the ends of the paper. The jars must have accurately ground glass stoppies. It is the best to use no kind of sealing wax to coat the joint of the stopple; simply wipe the glass perfectly dry, close the jar properly, and there will be little danger of evaporation. Do not let the direct sunlight strike your jars, and keep them well removed from stoves, registers, and the like.—Proceedings of the National Museum.

LIFE WITHOUT MICROBES.

A RECENT series of experiments on this new and interesting subject is described in Natural Science, London, April, as follows:

"In these days it is chiefly the evil effects of bacteria upon organisms that are studied. Every week some new microbe of disease is discovered, or some old enemies are described as lurking in some unsuspected place. But there is another side to the microbe question. It has been known for long that many kinds of bacteria, normally present in the intestine, aid in the digestion of food, chiefly acting as ferments, altering food material into substances that can be absorbed by the cells of the intestine. Dr. J. Kijanizin, of the University of Kieff, gives in a recent number of the Archives de Biologie the remarkable results of a series of investigations he has made upon the influence of sterilized air. He devised an apparatus in which small animals could be kept for a number of days, while the air they breathed and the food they ate were supplied, so far as possible, in an absolutely sterilized condition. Although it was not possible to be certain that the food contained no bacteria, it was certain that the air supplied them had been quite freed from microbes; for a gelatin plate, placed in the current, remained without colonies all through the experiments. The animals were weighed before and after the experiments, and their excreta during the experiment were analyzed. Parallel experiments in which all the conditions but the sterilization were identical, were made.

"The experiments seemed to show first that there was a remarkable decrease in the assimilation of nitrogenous matter when the air and the food were deprived of micro-organisms. No doubt, the reason of the decrease was that these micro-organisms aid in the decomposition and peptonizing of the nitrogenous matter in the intestine. Were it possible to remove all the micro organisms from the intestine before the beginning of the experiment, the author thinks that the decrease in the assimilation of nitrogen would be still greater.

"A second result was that the animals lost weight more quickly under the sterilized conditions than under normal conditions, while, at the same time, the excretion of nitrogen and of carbonic acid was more than usual.

"A third result was still more remarkable. In a large number of the experiments the animals died, sometimes a few minutes, more often a few hours or a few days, after the beginning of the experiment. No cause could be assigned for this. The possible causes were all excluded, and the inexplicable fact remained. The novelty of the idea that sterilization of the air is fatal to life no doubt is attractive; but we agree with the writer of the paper, that even his careful and laborious experiments are not sufficient to justify the belief that microbes in the air are necessary to the life of air-breathing animals. Physiologists will remember the experiments of Dr. Haldane, at Oxford, which showed that animals were not poisoned by their own organic exhalations. It is clear enough that a very large amount of work must be done before respiration is understood."

RESULTS OF EXCAVATIONS IN THE MEMPHIS NECROPOLIS, DASHUR, AND LISHT.

THE necropolis of Dashur, which during the last two years has been the ground of so many splendid finds, seems to be inexhaustible, as M. J. de Morgan, the happy discoverer of the treasures of Princesses Ita and Khnoumit's, has recently made a new discovery. This time it comes in the shape of an epigraphic document of the highest interest. On the border of the desert, close by the Nile Valley, between Amenemhat II's pyramid, near which the above mentioned treasures were found, and that of Amenemhat III, M. de Morgan came upon the sepulcher of a high official named Si-Isit, who was "High Priest of Ptah, Arch Chancellor, and the King's friend," titles much thought of among the old Egyptians. As far as is known, the royal vaults of the three pyramids opened by M. de Morgan at Dashur [Amenemhat II, Usertesen III, and Amenemhat III] had no inscription on their walls. The only ones found were those of the shrines located outside of the eastern face of the pyramid and devoted to the worship of the dead Pharaoh. But Si Isit was a lord in his time, proud of his titles, so he enumerates them at full length. No less than 146 columns of hieroglyphs decorate the walls of his resting vault in connection with pictures carved in Toura limestone, on which he is represented seated and partaking with dignity of the funeral repast brought before him.

Si-Isit is an aged man, somewhat stout, with a stern physiognomy, his hair cut short, his skull compact, his lower lip hanging slightly. His portrait, full of individuality and expression, is fashioned by a master hand. The treatment of the chisel is broad and free even in the smallest details. The hieroglyphs, hardly measuring one inch, are carved with a perfection only attained by cameo cutters. Si-Isit ordered the construction of his tomb on a nearly royal plan, the disposition being very like that of King Unas at Saqqaarah. A passageway, covered with a roof made of large slabs placed at sharp angles, slopes gently under ground by an incline to the burial chamber, which is comparatively small (3·50 meters by 1·75 meters). This room is completely filled by an enormous sarcophagus in gray granite. To the left are two smaller rooms, one containing a monolithic canopy case of the same material. The spoliators discovered and ransacked this grave. Large pieces of carnelian, fragments of gold leaves, and bits of flagellum are the only witnesses left to show what were the treasures buried in that sepulcher.

This discovery would seem of small importance compared with the finds made previously at Dashur, if it were not for the inscriptions decorating the burial vaults of Si-Isit. These 146 vertical lines of hieroglyphs all carved in limestone and painted green, are documents of the highest interest, as they afford points of comparison with similar texts found by M. Maspero in the pyramids of Saqqaarah. They give an opportunity to study the transformations in the language and writing which may have taken place between the fifth and sixth dynasties and the twelfth, as both inscriptions are propitiatory formulas from the mortuary ritual, the study of which by philologists cannot fail to be a source of much information.

We must now turn to another point of the Memphis necropolis, to Lisht, its southern extremity. Since Mariette organized and took the direction of the service, the exploration of this important ground has always been reserved by the department. M. de Morgan this year made an exception to this rule in favor of the French mission, but under conditions that proved very beneficial to the Egyptian Museum. Mr. R. Gauthier was authorized to explore the surroundings of the two Lisht pyramids, he in the sole interest of science contributing liberally all the expenses of the work, while all the objects found remain the property of the Gizeh Museum. While the service reserved to itself the opening of the pyramids, the exploration of their vicinity and the mastabas was intrusted to the French mission. Since December last Messrs. Gauthier and Grequier have been at work. Their labors have been rewarded by discoveries of great historical interest. As they rightly reserve the privilege of publishing their finds, but few details are obtainable. It is known, however, that they have found ten statues in a perfect state of preservation, 1·80 meters high, say about six feet, hidden near the ruins of the chapel of the southern Lisht pyramid. They are finely executed and adorned with carved reliefs of an historical character; all represent Usertesen I, second King of the twelfth dynasty (2433 B. C. Mariette, or 2758–2714 B. C. Petrie). Further in the ruins of the temple of the pyramid the explorers discovered a splendid table of offerings in gray granite bearing the cartouch of King Usertesen I. It represents Egyptian gnomes bringing their offerings to the monarch. A dozen similar monuments of less importance, besides fragments of inscription, were found during the work, and through them the southern pyramid of Lisht was identified as the resting place of Usertesen I, thus corroborating the opinion expressed by M. Maspero.

These pyramids are in a much dilapidated condition; the casings have been carried away and look in the distance like shapeless mounds. The royal vaults have never been entered by modern explorers. They possess a peculiarity which makes it a very laborious undertaking to open them. The passageway is of granite and the obstruction is of blocks of the same material fitting tight, which have been left to slide down by their own weight in the inclined tube-like passageway. M. Maspero, when director of the department of antiquities, made an attempt to force his way into the sepulchral room. He had a portion of the granite obstruction cut and removed, but was prevented from going any further by the inrush of water. M. de Morgan is determined to enter the royal vault; his plan was all prepared for this year's campaign of excavation, but his presence at Dashur was imperatively needed, so that the work has been postponed. We are waiting with interest for Mr. Gauthier's official report on his discoveries, and congratulate him on his success and liberality to science.—New York Sun.

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